

ELECTROPHOTOGRAPHIC PHOTSENSITIVE MEMBER, PROCESS  
CARTRIDGE AND ELECTROPHOTOGRAPHIC APPARATUS

BACKGROUND OF THE INVENTION

5 Field of the Invention

This invention relates to an electrophotographic photosensitive member, and a process cartridge and an electrophotographic apparatus which have the electrophotographic photosensitive member.

10 Related Background Art

In recent years, for the purpose of overcoming disadvantages of inorganic electrophotographic photosensitive members making use of inorganic photoconductive materials, organic electrophotographic photosensitive members making use of organic photoconductive materials are energetically put forward. In order to satisfy both electrical properties and mechanical properties, organic electrophotographic photosensitive members are often provided with a photosensitive layer which is a multi-layer type (function-separated type) photosensitive layer in which a charge generation layer containing a charge-generating material and a charge transport layer containing a charge-transporting material are superposingly formed.

25 Electrophotographic photosensitive members are required to have a stated sensitivity, electrical properties and optical properties which have been

adapted to electrophotographic processes applied.

Electrophotographic photosensitive members are also required to have durability to electrical and mechanical external forces because such forces are directly applied thereto through corona charging or contact charging,  
5 imagewise exposure, development by toner, image transfer, surface cleaning and so forth.

As methods for improving wear resistance of the surfaces of organic electrophotographic photosensitive members, known in the art are a method in which the binder resin of a surface layer is made to have a high  
10 molecular weight, a method in which a filler is added to the binder resin of a surface layer, a method in which the structure of a binder resin is incorporated with a siloxane structure or a structure for imparting  
15 lubricity (slipperiness) such as a fluorine-containing substituent or a solid lubricant such as polytetrafluoroethylene (PTFE) is added so as to reduce the coefficient of friction with cleaning means such as  
20 a cleaning blade.

As another method for improving wear resistance of the surfaces of organic electrophotographic photosensitive members, it is proposed to use a binder resin having good mechanical strength.

25 However, even if the binder resin itself has good mechanical strength, its use in mixture with a low-molecular-weight charge-transporting material can

not sufficiently make the most of the mechanical strength the binder resin has originally, and such a binder resin has not necessarily achieved satisfactory durability (wear resistance or scratch resistance). On  
5 the other hand, if the charge-transporting material is added in a smaller quantity in an attempt to make the most of the mechanical strength the binder resin has originally, a problem may arise such that it causes a lowering of electrophotographic sensitivity or a rise of  
10 residual potential. That is, this proposal has not achieved both the surface mechanical strength and the electrophotographic performance.

The method in which lubricity is imparted to the surfaces of electrophotographic photosensitive members  
15 to reduce the coefficient of friction with cleaning means such as a cleaning blade may also cause a lowering of the surface mechanical strength, and has not succeeded in achievement of sufficient durability.

The use of a high-molecular weight  
20 charge-transporting material for the purpose of better preventing the electrophotographic photosensitive member surface from having a low mechanical strength because of the addition of a low-molecular-weight  
charge-transporting material is disclosed in Japanese  
25 Patent Applications Laid-open No. 64-9964, No. 2-282263, No. 3-221522, No. 8-208820 and so forth. In many of these, however, it is not necessarily the case that the

surfaces have sufficient wear resistance. Even in those having a mechanical strength to a certain extent as well, there has been a disadvantage that the manufacturing cost is too high to be suited for practical use.

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#### SUMMARY OF THE INVENTION

An object of the present invention is to solve the above problems to provide an electrophotographic photosensitive member having high surface mechanical strength, having superior durability (wear resistance or scratch resistance) and also having stability in repeated use, and a process cartridge and an electrophotographic apparatus which have such an electrophotographic photosensitive member.

10 That is, the present invention is an electrophotographic photosensitive member comprising a support, and provided thereon a photosensitive layer, wherein;

a surface layer of the electrophotographic photosensitive member contains:

an electrically insulating binder resin; and

a random-copolymer type high-molecular-weight charge-transporting material having a repeating structural unit represented by the following Formula (11) and a repeating structural unit represented by the following Formula (12):

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wherein  $\text{Ar}^{111}$  and  $\text{Ar}^{121}$  each independently represent a substituted or unsubstituted divalent aromatic hydrocarbon ring group other than a phenylene group, or a substituted or unsubstituted divalent aromatic heterocyclic ring group, and  $\text{Ar}^{112}$  and  $\text{Ar}^{122}$  each independently represent a substituted or unsubstituted monovalent aromatic hydrocarbon ring group or a substituted or unsubstituted monovalent aromatic heterocyclic ring group; provided that a case is excluded in which the repeating structural unit represented by Formula (11) and the repeating structural unit represented by Formula (12) are identical in structure.

The present invention is also a process cartridge and an electrophotographic apparatus which have the above electrophotographic photosensitive member.

## BRIEF DESCRIPTION OF THE DRAWING

Figure is a schematic view showing an example of

the construction of an electrophotographic apparatus provided with a process cartridge having the electrophotographic photosensitive member of the present invention.

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#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is described below in detail.

The electrophotographic photosensitive member of the present invention has a support and a photosensitive  
10 layer provided on the support, and has a surface layer containing an electrically insulating binder resin and a specific high-molecular-weight charge-transporting material.

The surface layer contains as the  
15 high-molecular-weight charge-transporting material a random-copolymer type high-molecular-weight charge-transporting material having a repeating structural unit represented by the above Formula (11) and a repeating structural unit represented by the above  
20 Formula (12). This random-copolymer type high-molecular-weight charge-transporting material is by no means limited to the copolymer or bipolymer, and may be incorporated with three or more repeating structural units as long as the effect of the present invention is  
25 not damaged. From the viewpoint that the effect of the present invention is not damaged and where the number of the repeating structural unit represented by the above

Formula (11) is  $k$ , the number of the repeating structural unit represented by the above Formula (12) is  $m$  and the total number of repeating structural units the random-copolymer type high-molecular-weight

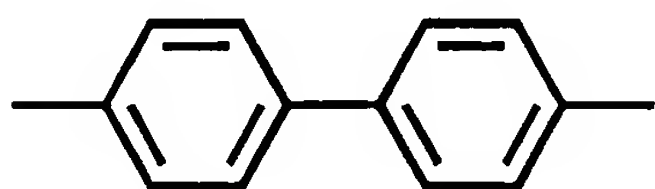
5 charge-transporting material has is  $s$ , the value of  $(k + m)/s$  may preferably be in the range of from 0.5 to 1, more preferably from 0.75 to 1 and still more preferably 1. The value of  $k/m$  may also preferably be in the range of from 1 to 30.

10 In the present invention, the random copolymer is meant to be a copolymer obtained by, as shown in Synthesis Examples given later, introducing two or more kinds of monomer materials simultaneously in a reaction vessel at the time of synthesis reaction for the  
15 copolymer to allow them to react, without making any artificial control that may cause polymerization reaction having regularity as in the case of alternating copolymers or block copolymers (usually, polymeric products synthesized by such a synthesis method are  
20 considered to stand random copolymers). Thus, the random-copolymer type high-molecular-weight charge-transporting material is meant to be a high-molecular-weight charge-transporting material synthesized by the above synthesis method. For example,  
25 where the repeating structural units are represented by A and B, the random copolymer is a copolymer having irregular arrangement such as AAABAA, ABABBA or AABBABA.

The alternating copolymer is a copolymer having regular arrangement, ABABAB. The block copolymer is a copolymer with variety in length for each repeating structural unit, such as AAABBB or AAAAABBBB, but with the  
5 respective repeating structural units present as blocks.

In the above Formulas (11) and (12),  $\text{Ar}^{111}$  and  $\text{Ar}^{121}$  each independently represent a substituted or unsubstituted divalent aromatic hydrocarbon ring group other than a phenylene group, or a substituted or  
10 unsubstituted divalent aromatic heterocyclic ring group; and  $\text{Ar}^{112}$  and  $\text{Ar}^{122}$  each independently represent a substituted or unsubstituted monovalent aromatic hydrocarbon ring group or a substituted or unsubstituted monovalent aromatic heterocyclic ring group; provided  
15 that a case is excluded in which the repeating structural unit represented by Formula (11) and the repeating structural unit represented by Formula (12) are identical in structure.

The  $\text{Ar}^{111}$  in the repeating structural unit  
20 represented by Formula (11) and the  $\text{Ar}^{121}$  in the repeating structural unit represented by Formula (12) may also each independently be a divalent group having structure represented by one Formula selected from the group consisting of the following Formulas (21) to (26).



(21)





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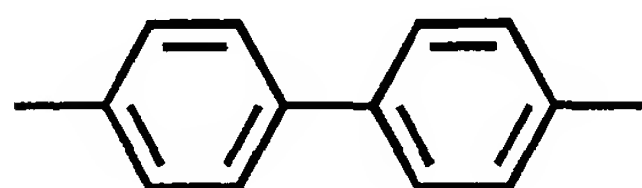
In Formula (22),  $R^{221}$  and  $R^{222}$  each independently represent a hydrogen atom, a substituted or unsubstituted alkyl group or a substituted or unsubstituted phenyl group. In Formula (23),  $R^{231}$  represents a substituted or unsubstituted alkyl group or

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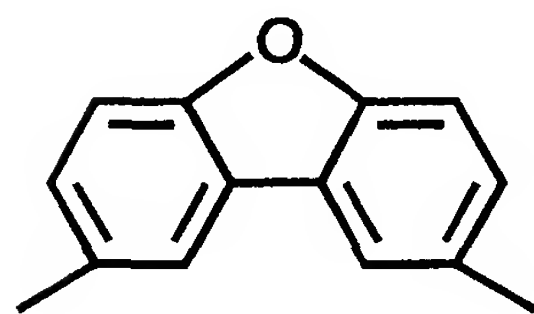
a substituted or unsubstituted phenyl group.

It is more preferable that the  $\text{Ar}^{111}$  in Formula (11) is a divalent group having structure represented by the following Formula (21) and that the  $\text{Ar}^{121}$  in Formula (12) is not a divalent group having structure represented by the following Formula (21). It is still more preferable that the  $\text{Ar}^{121}$  in Formula (12) is a divalent group having structure represented by the following Formula (24) or (25).

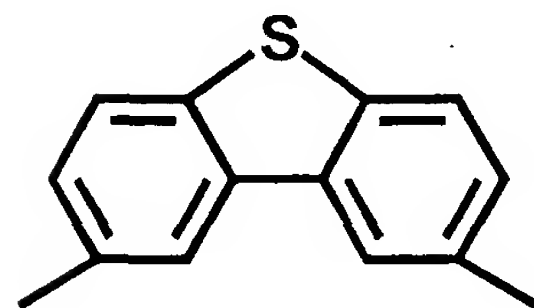
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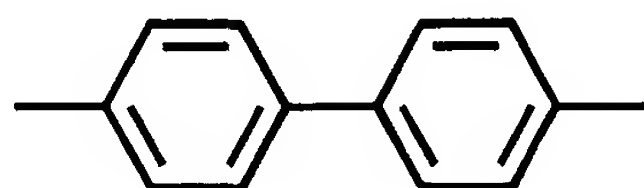
(24)



(25)

It is also more preferable that the  $\text{Ar}^{111}$  in Formula (11) and the  $\text{Ar}^{121}$  in Formula (12) are divalent groups which are identical in structure, that the  $\text{Ar}^{112}$  in Formula (11) and the  $\text{Ar}^{122}$  in Formula (12) are monovalent groups which are different in structure from each other, that at least one of  $\text{Ar}^{112}$  and  $\text{Ar}^{122}$  has an

electron attractive group and also that the  $\text{Ar}^{111}$  in Formula (11) and the  $\text{Ar}^{121}$  in Formula (12) are divalent groups having structure represented by the following Formula (21).



(21)

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Where in the random-copolymer type high-molecular-weight charge-transporting material the number of side chains having no electron attractive group is represented by B and the number of side chains having electron attractive groups by A, the value of B/A may preferably be in the range of from 2 to 40.

The above monovalent aromatic hydrocarbon ring group may include monovalent groups such as naphthalene, anthracene, perylene, fluorene, biphenyl and terphenyl from which one hydrogen atom has been removed. The above monovalent aromatic heterocyclic ring group may include monovalent groups such as carbazole, furan, benzofuran, thiophene, benzothiophene, quinoline, phenazine, dibenzothiophene, dibenzofuran and carbazole from which one hydrogen atom has been removed.

The above divalent aromatic hydrocarbon ring group may include divalent groups such as naphthalene, anthracene, perylene, fluorene, biphenyl and terphenyl from which two hydrogen atoms have been removed. The above divalent aromatic heterocyclic ring group may

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include divalent groups such as carbazole, furan, benzofuran, thiophene, benzothiophene, quinoline, phenazine, dibenzothiophene, dibenzofuran and carbazole from which two hydrogen atoms have been removed.

5           The above alkyl group may include a methyl group and an ethyl group.

          The substituent each of the above groups may have may include alkyl groups such as a methyl group, an ethyl group, a propyl group and a butyl group; alkoxyl  
10 groups such as a methoxyl group, an ethoxyl group and a propoxyl group; aryloxyl groups such as a phenoxyl group and a naphthoxyl group; halogen atoms such as a fluorine atom, a chlorine atom and a bromine atom; and  
di-substituted amino groups such as a dimethylamino  
15 group, a diethylamino group and a diphenylamino group.

          The electron attractive group may include halogen atoms such as a fluorine atom and a chlorine atom, and fluorine-atom-substituted alkyl groups such as a trifluoromethyl group, as well as a cyano group and a  
20 nitro group.

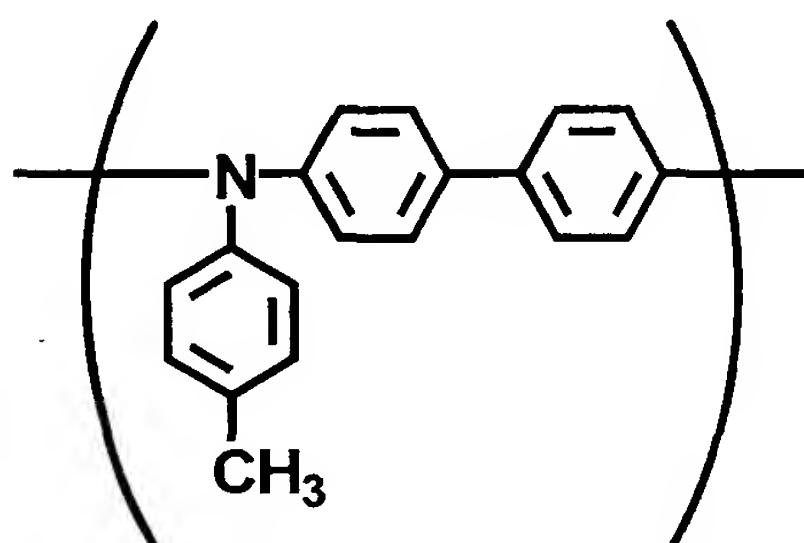
          The random-copolymer type high-molecular-weight charge-transporting material used in the present invention may also preferably have a weight-average molecular weight  $M_w$  of 1,500 or more, and on the other  
25 hand 9,000 or less, more preferably 5,000 or less, and still more preferably 3,000 or less.

Examples of the repeating structural units

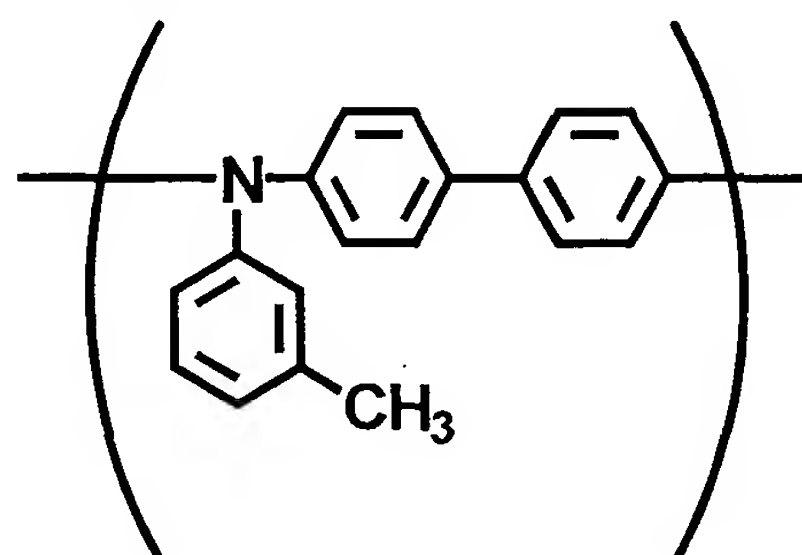
constituting the random-copolymer type  
high-molecular-weight charge-transporting materials of  
the present invention are shown below. The present  
invention is by no means limited to these.

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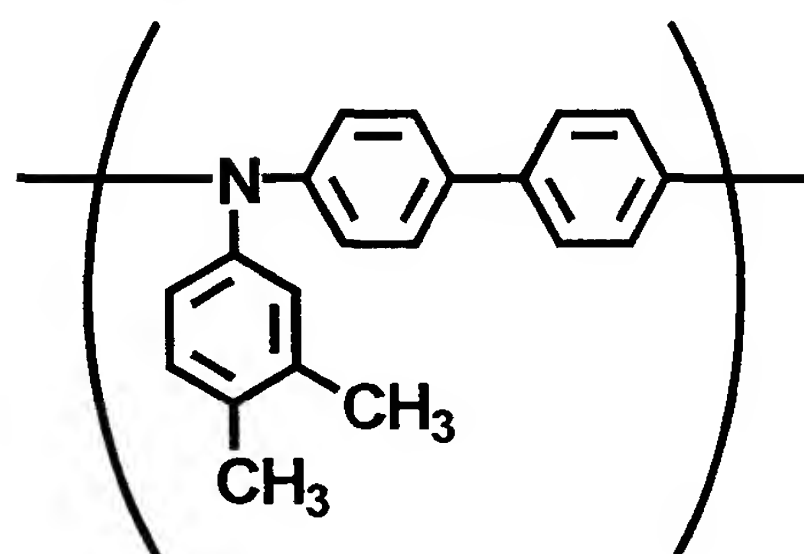
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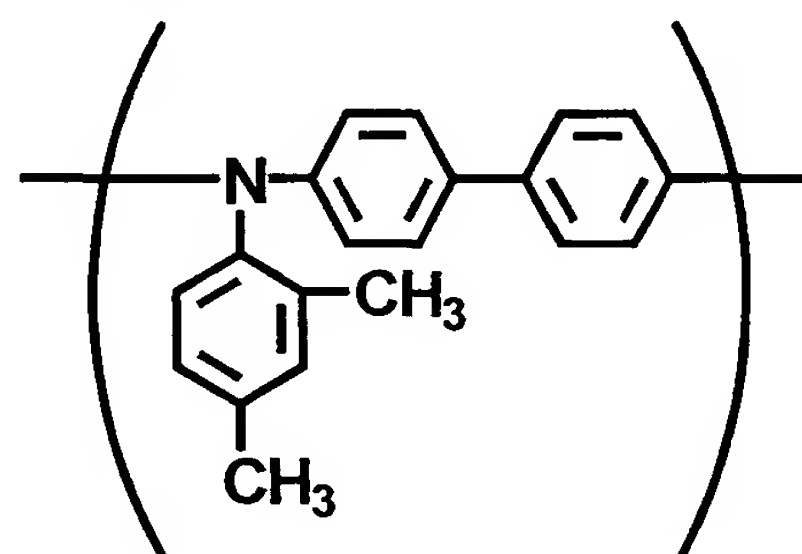
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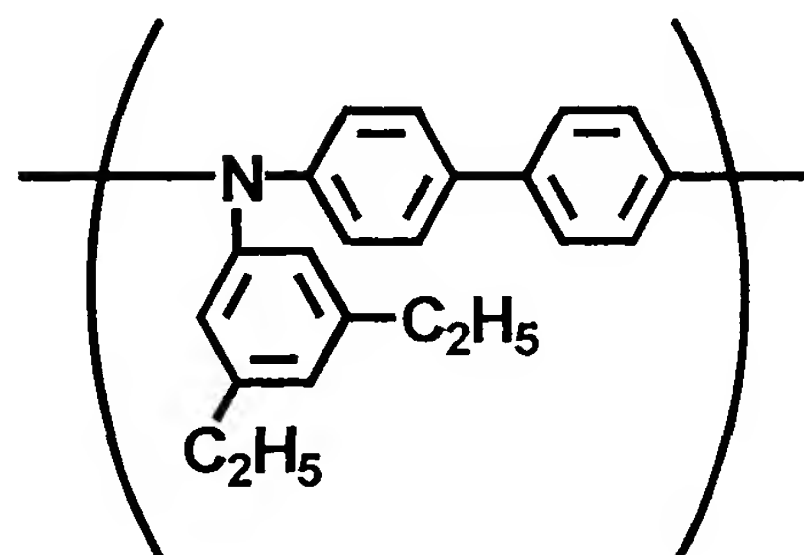
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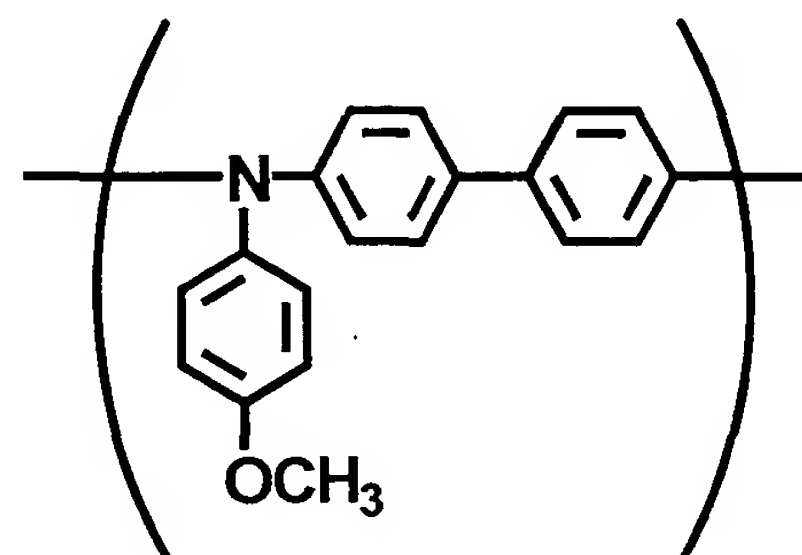
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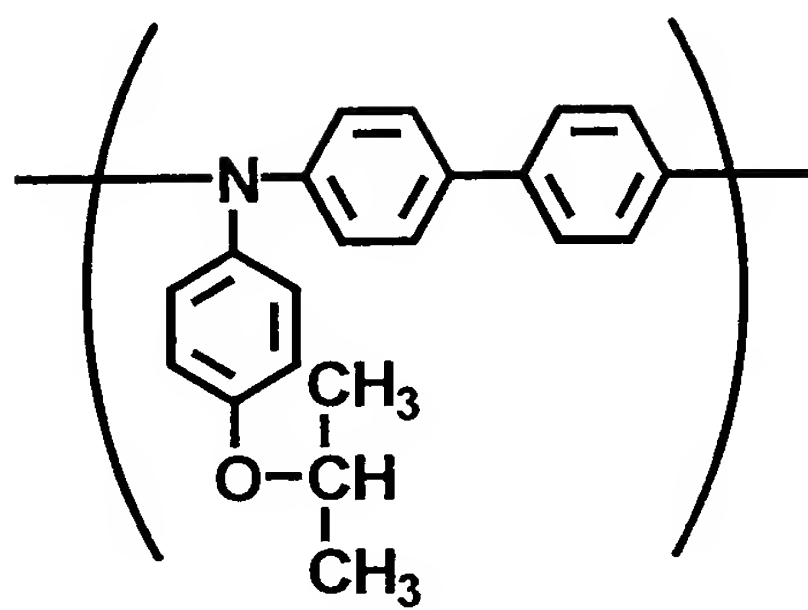
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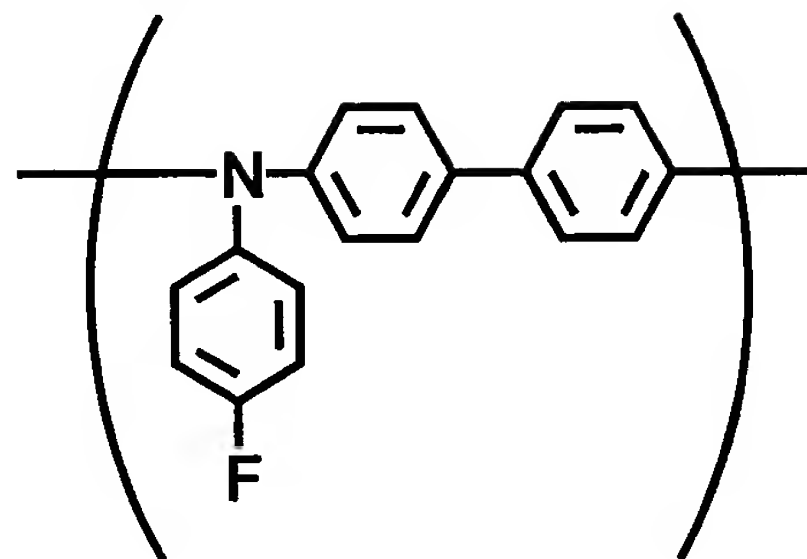
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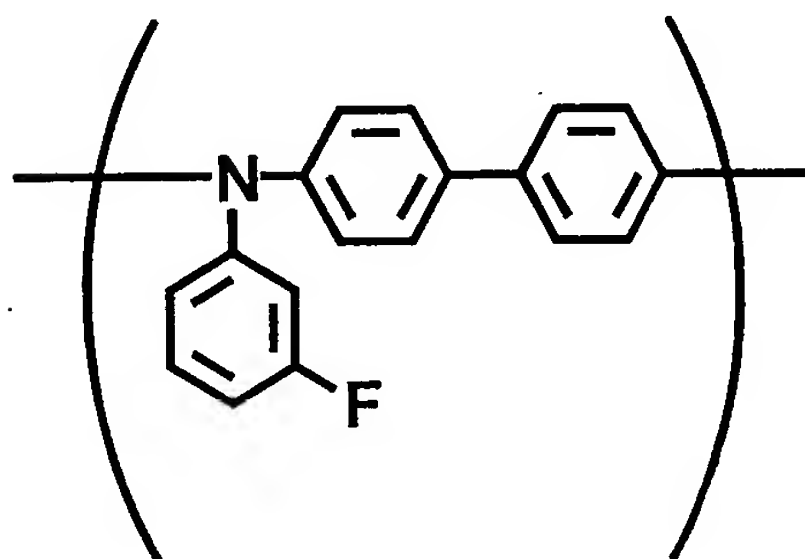
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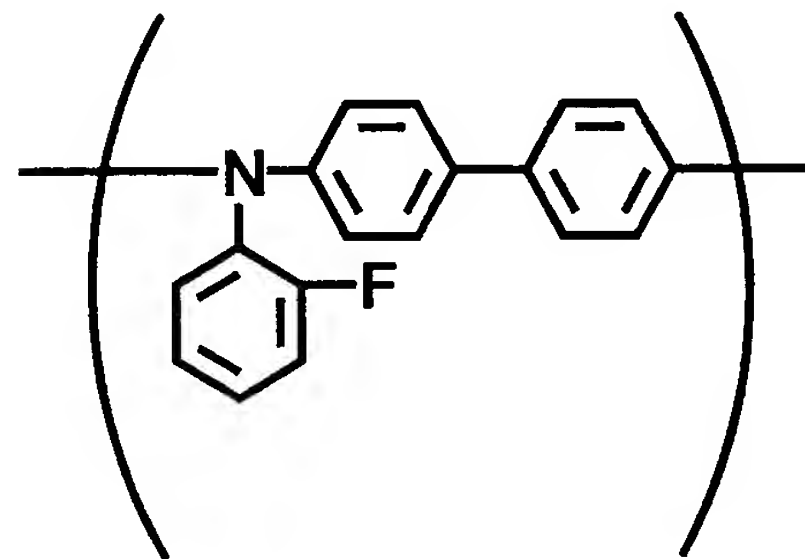
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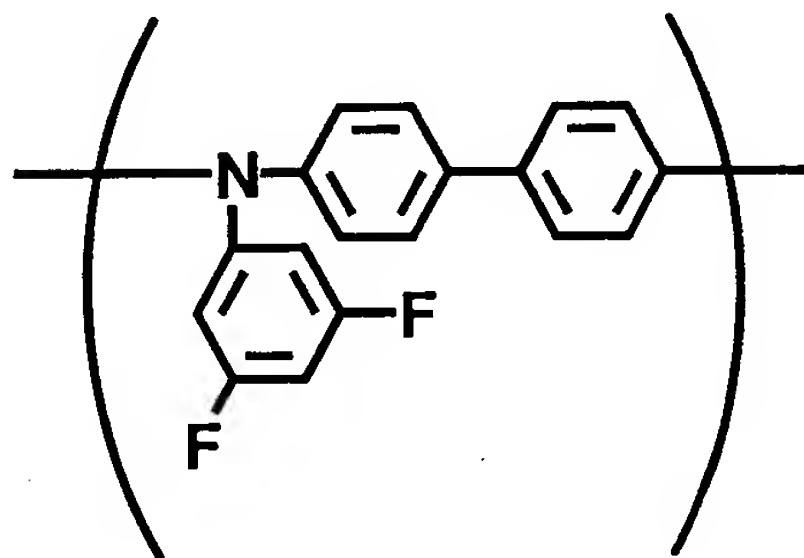
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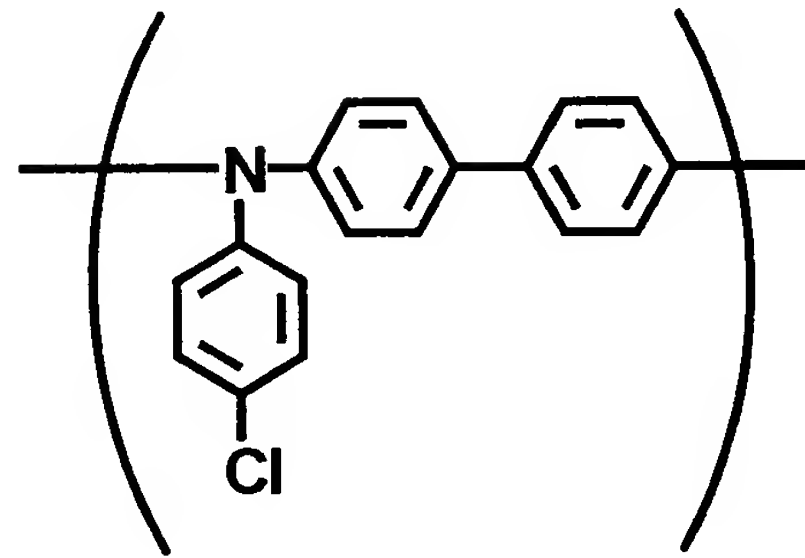
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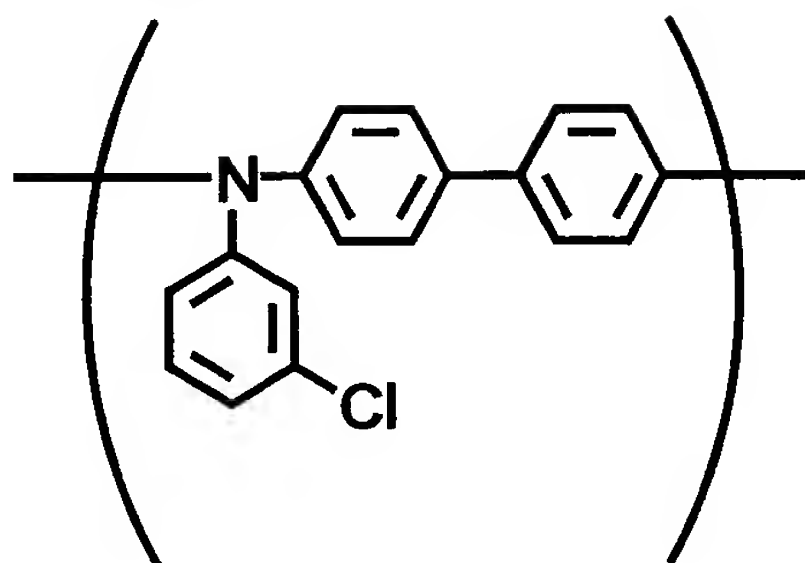
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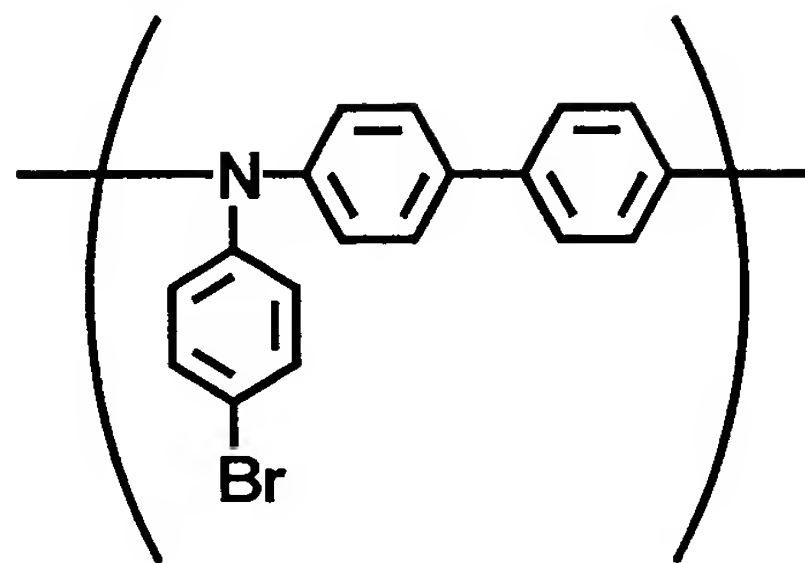
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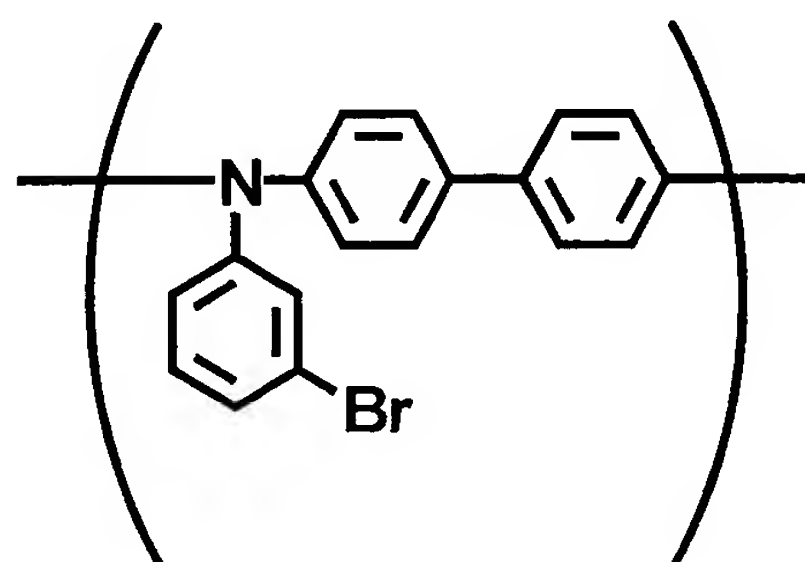
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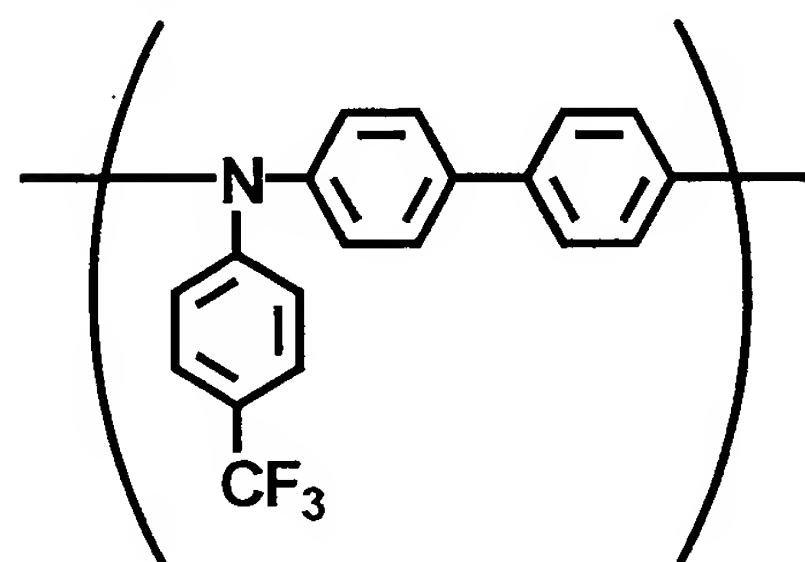
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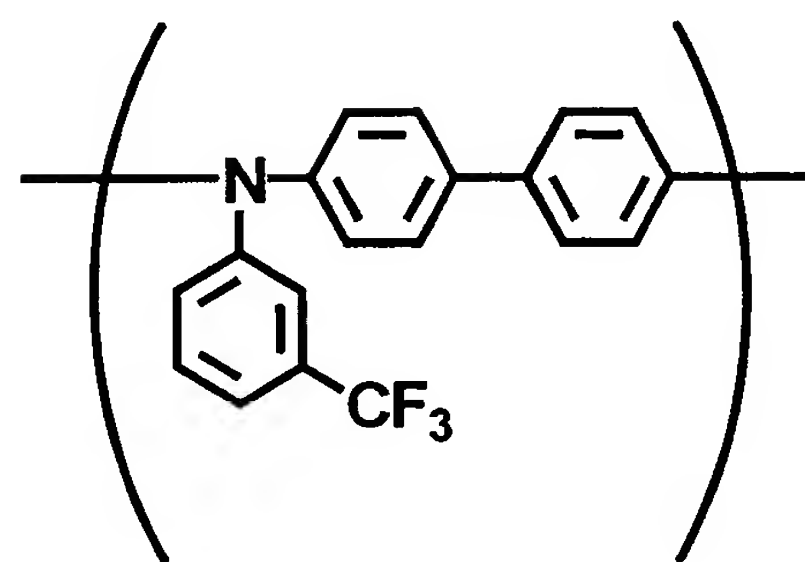
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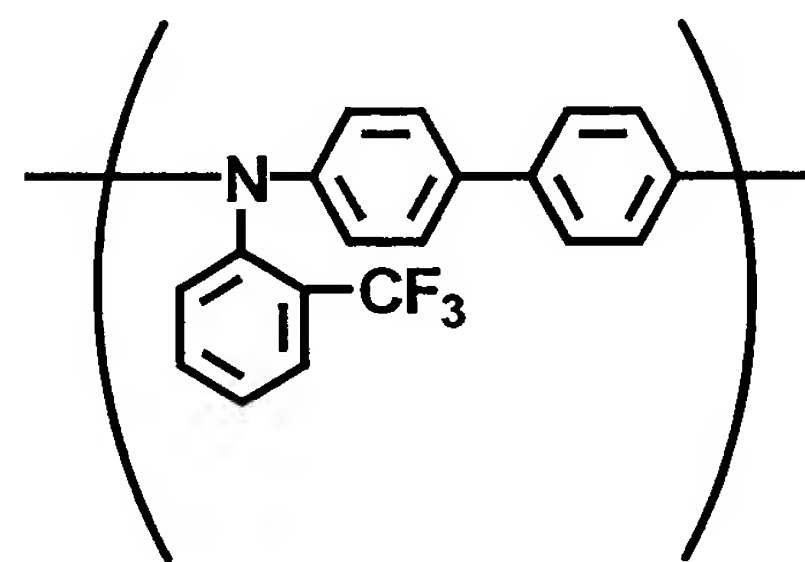
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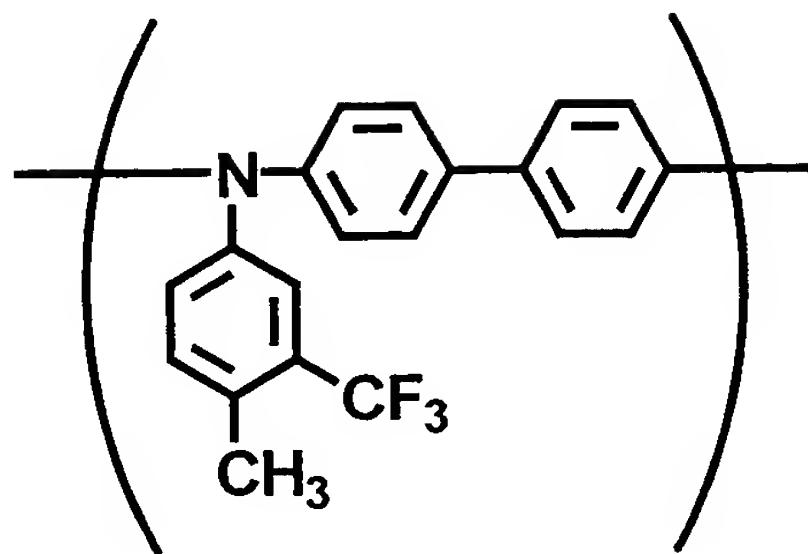
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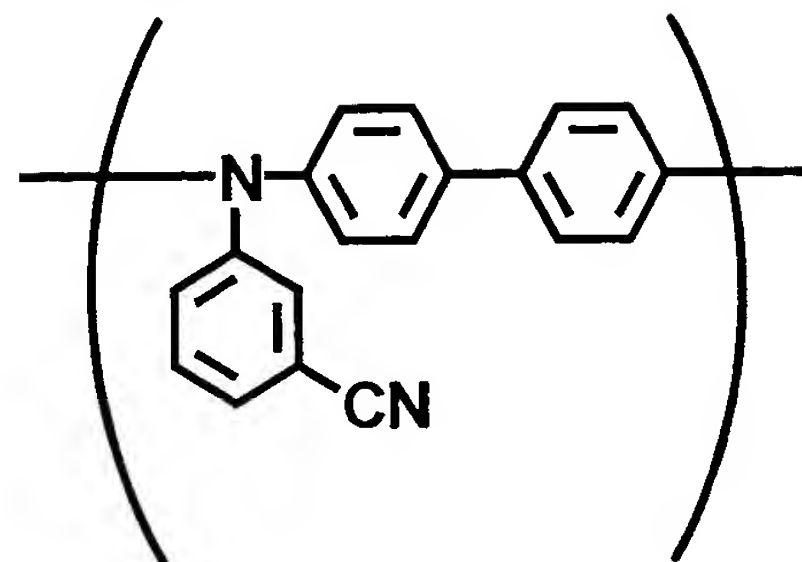
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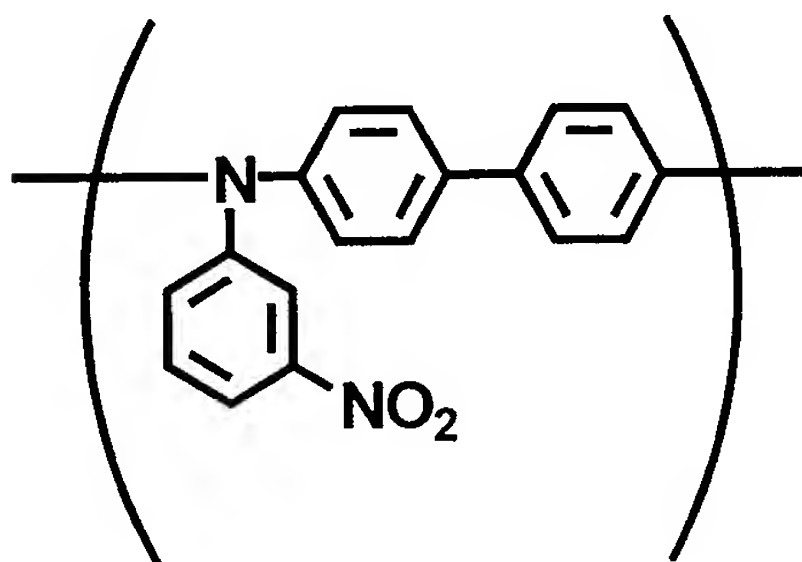
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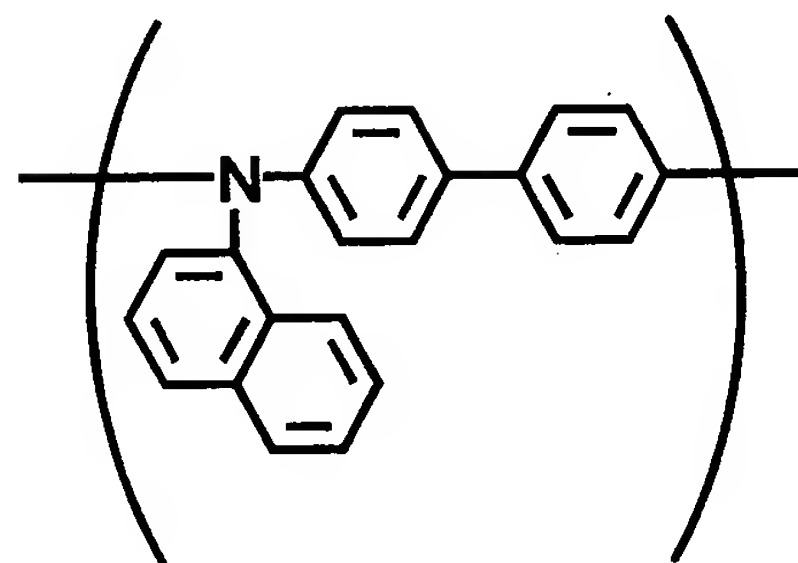
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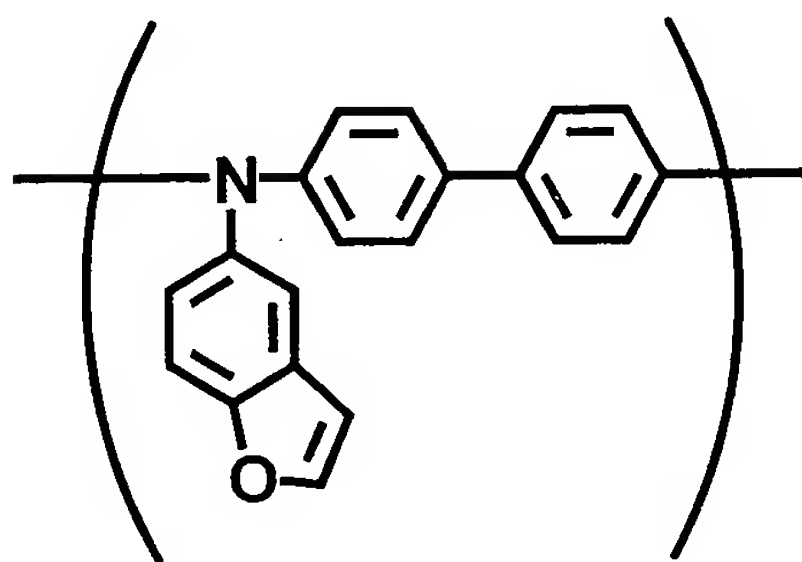
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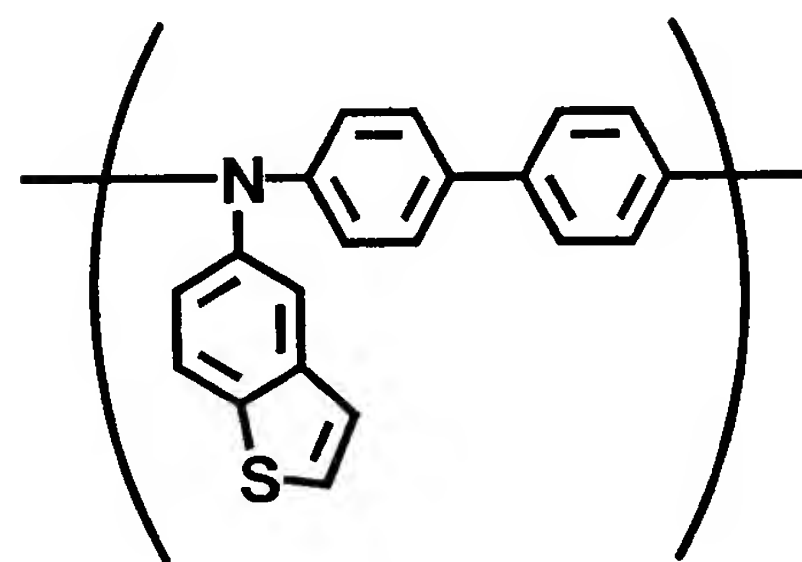
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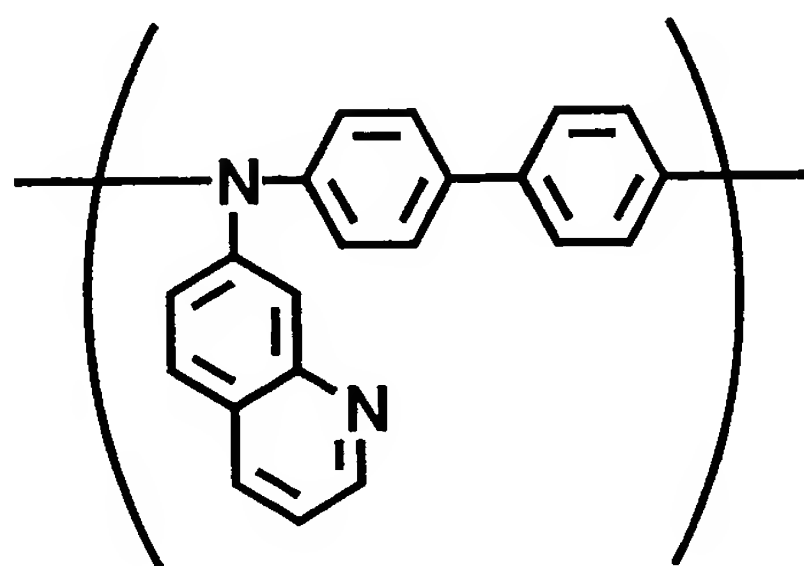


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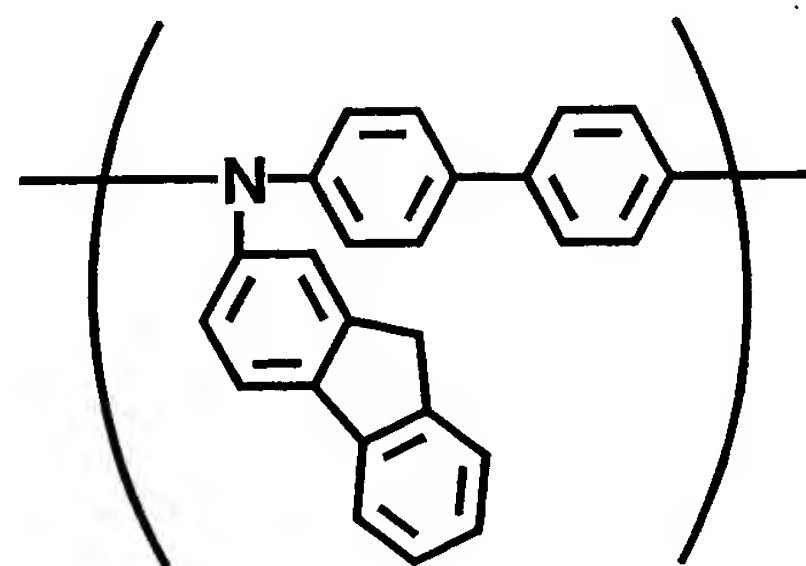




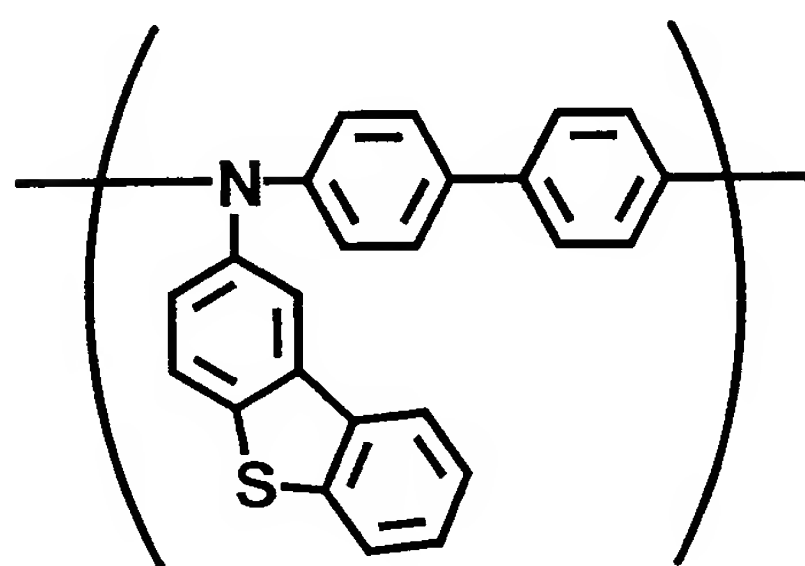
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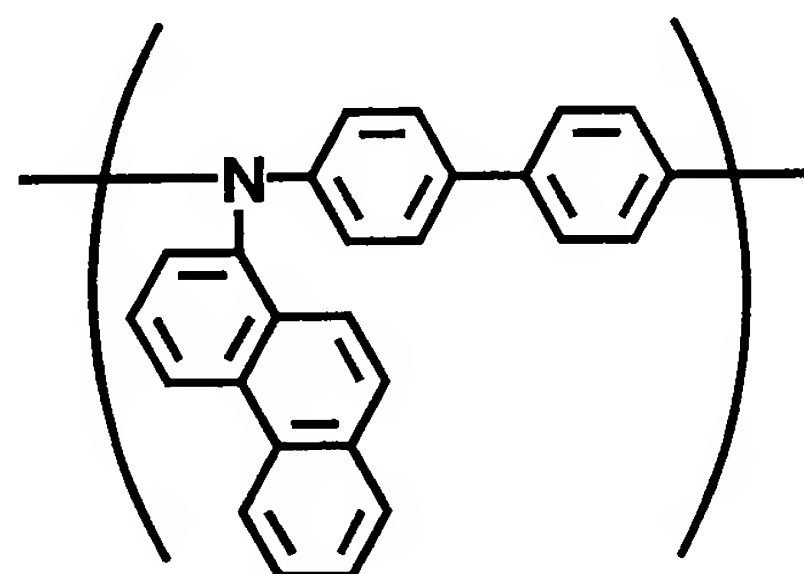
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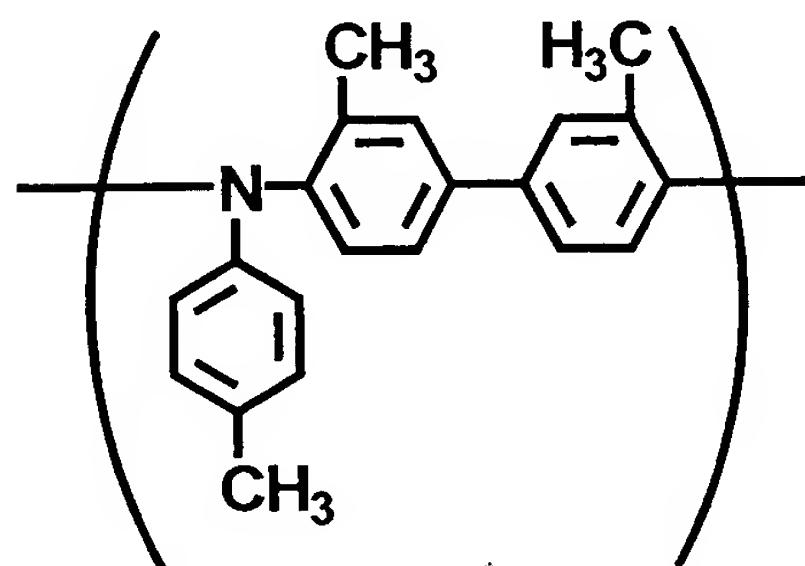
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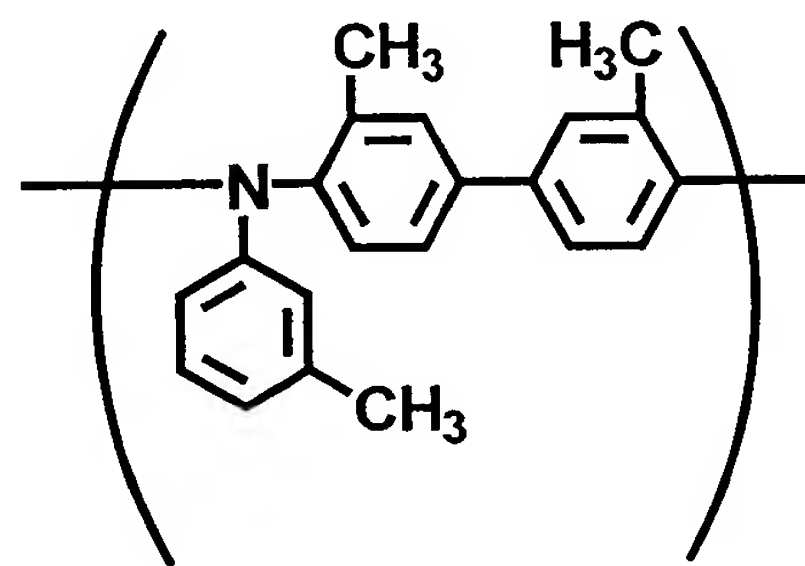
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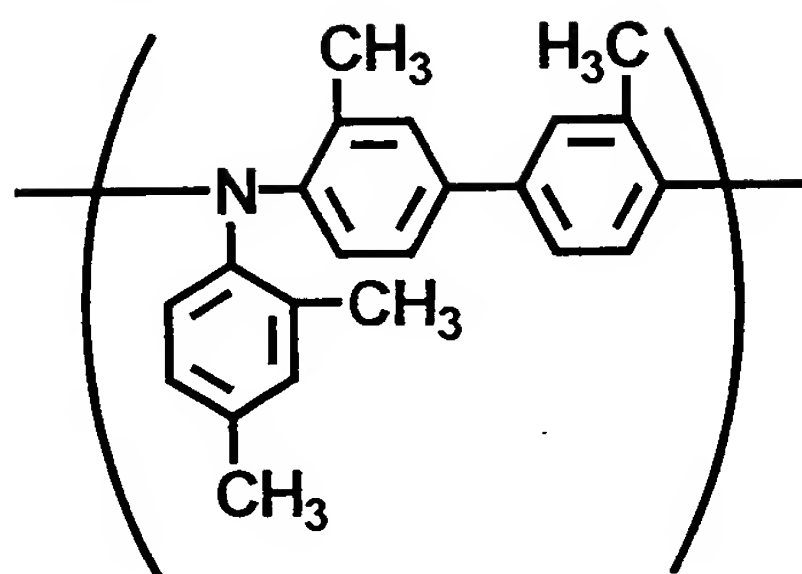
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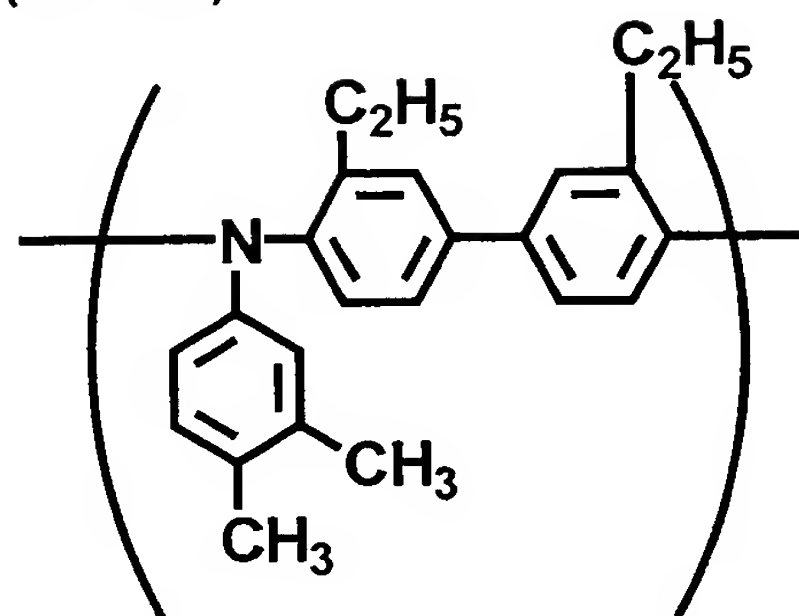
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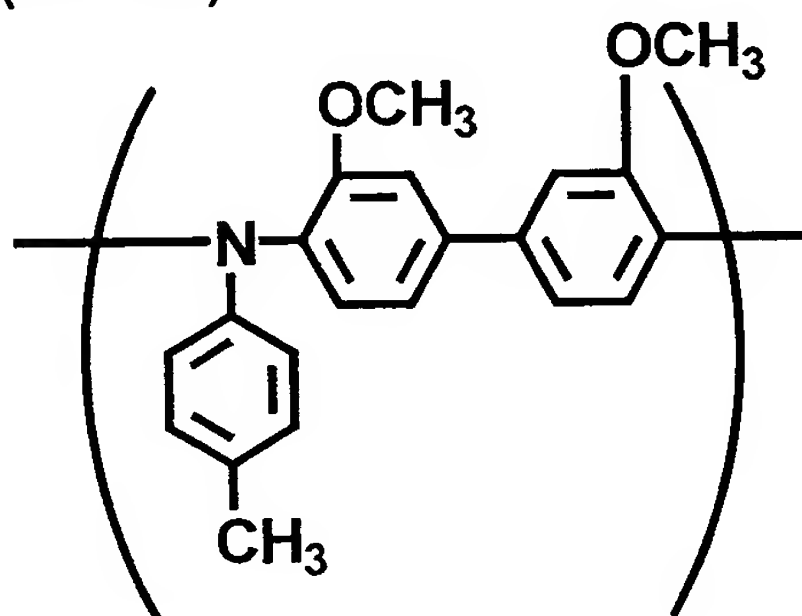
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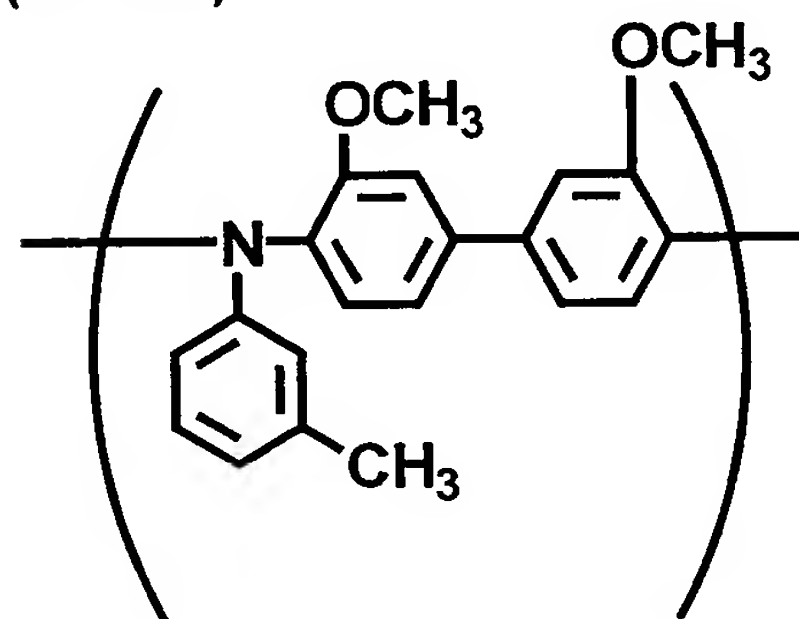
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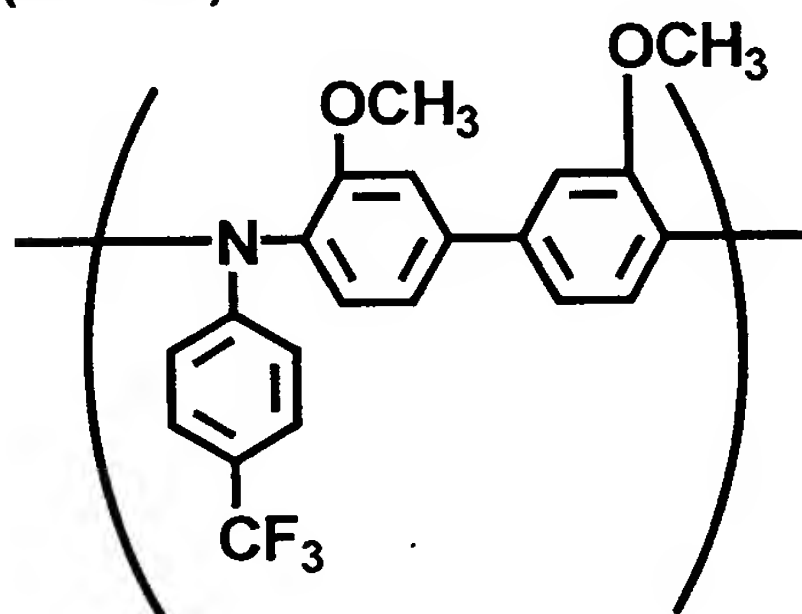
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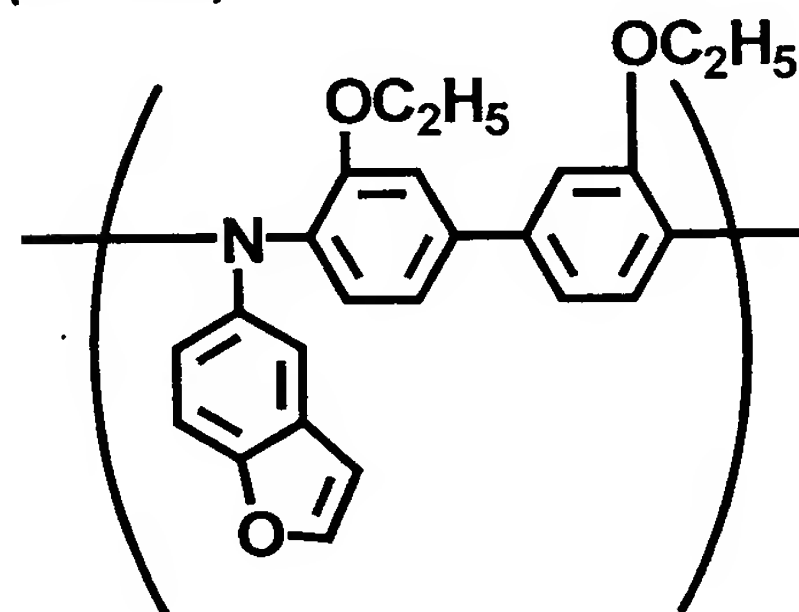
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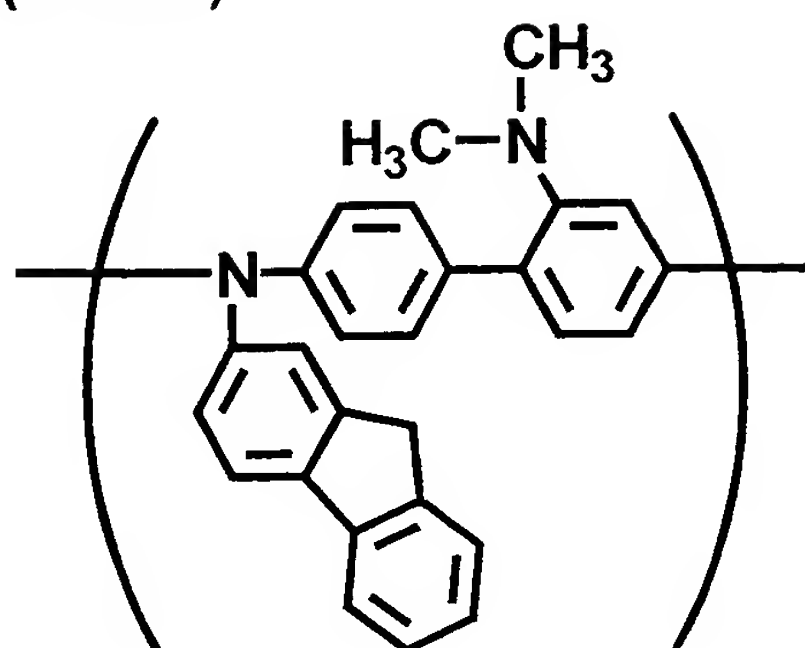
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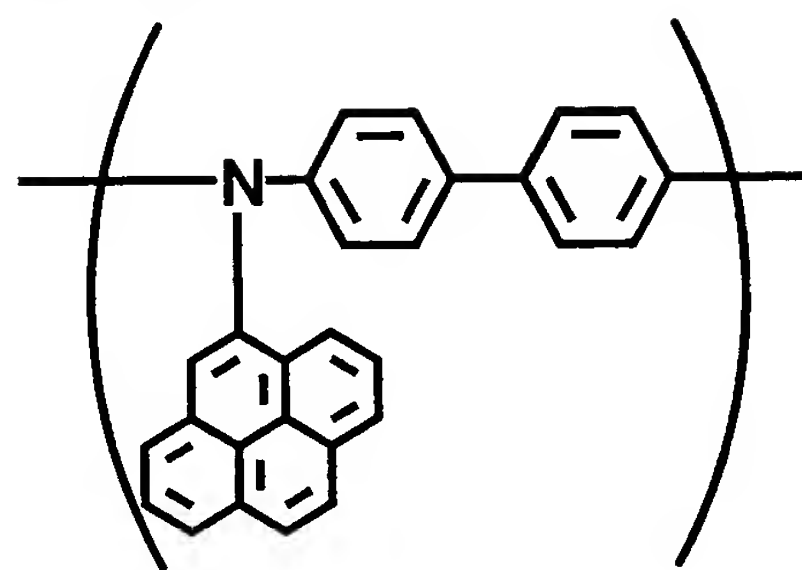
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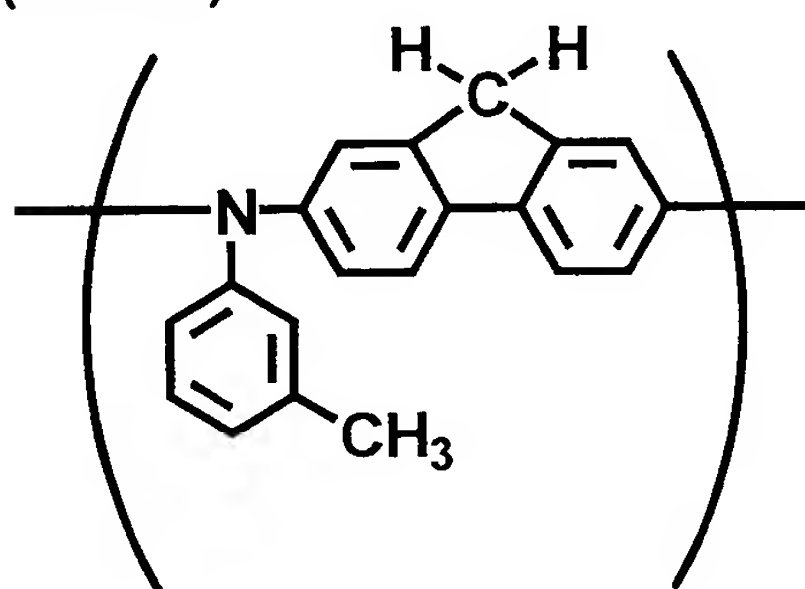
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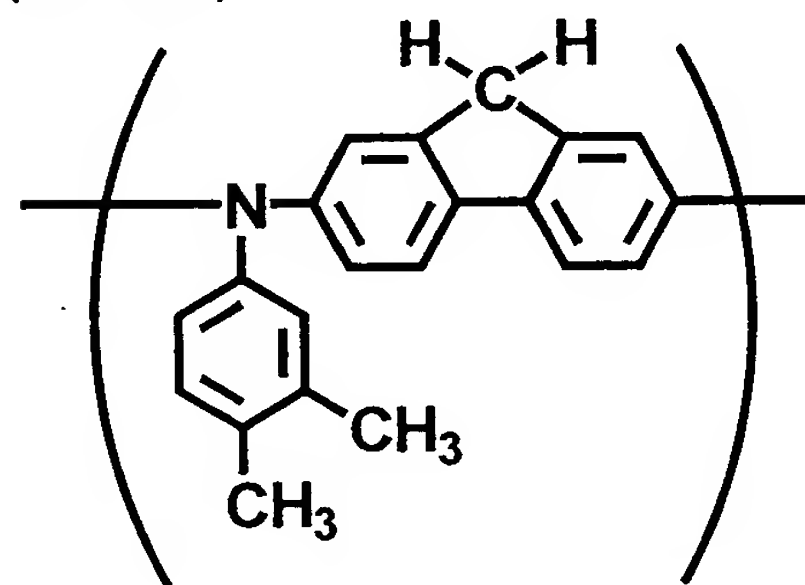
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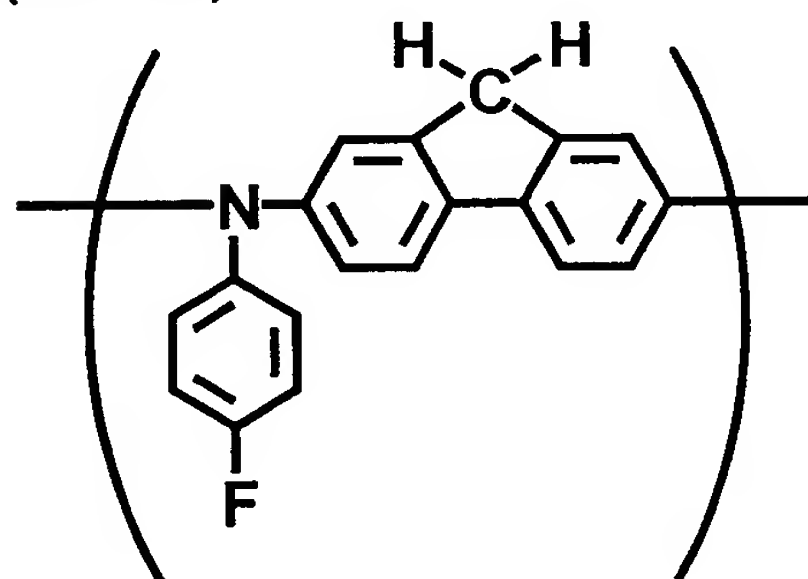
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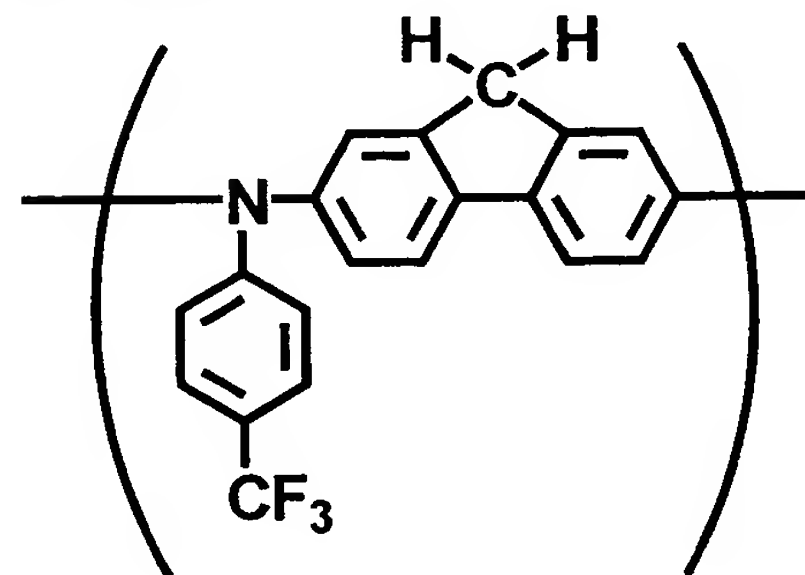
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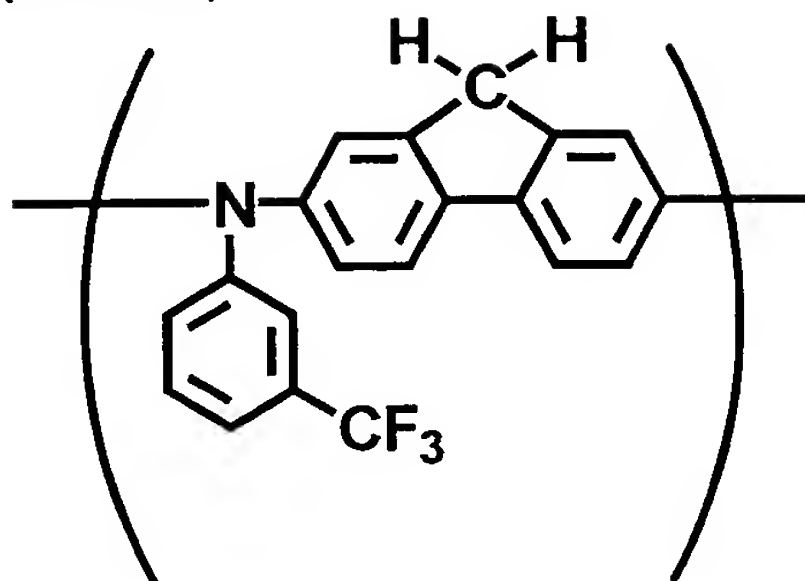
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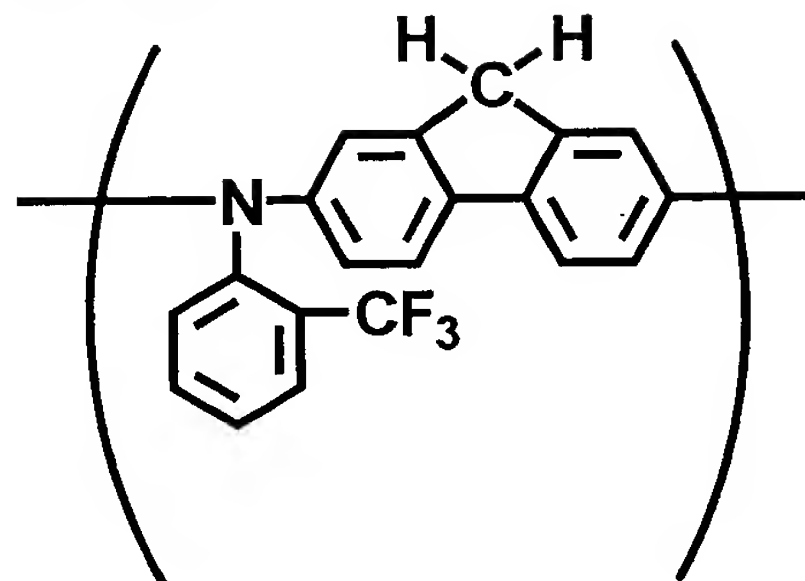
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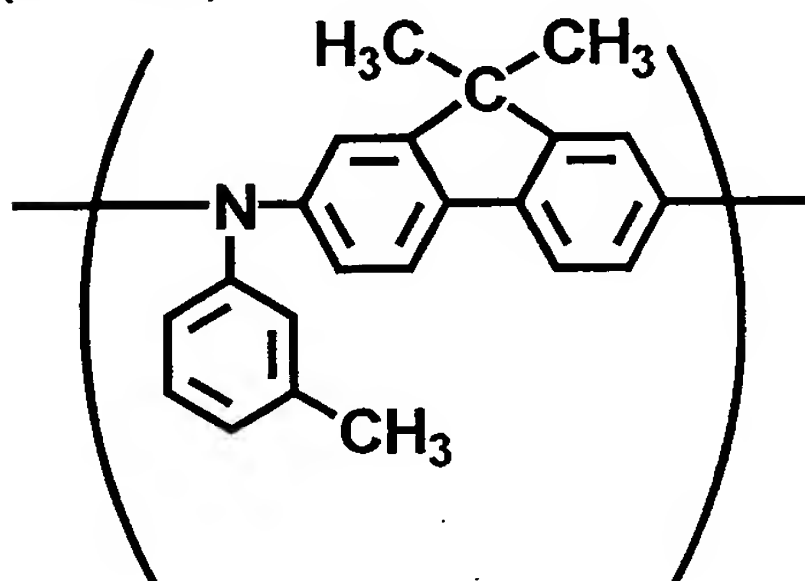
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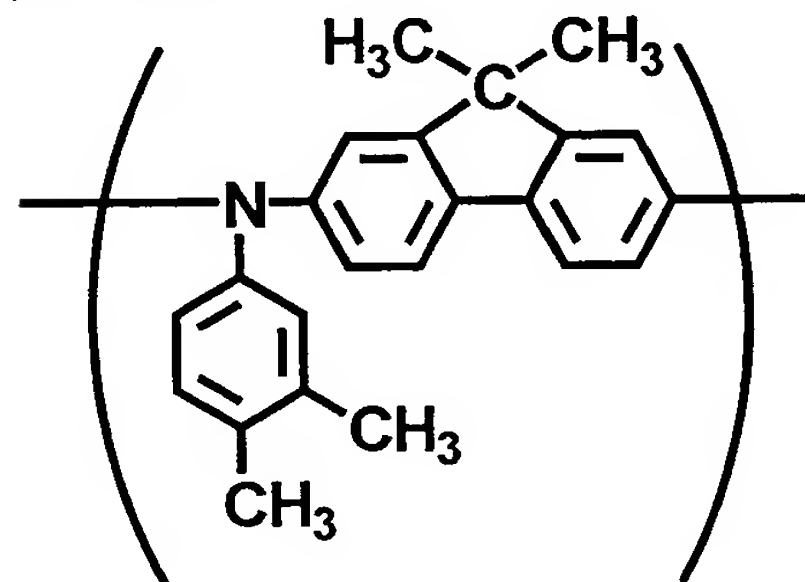
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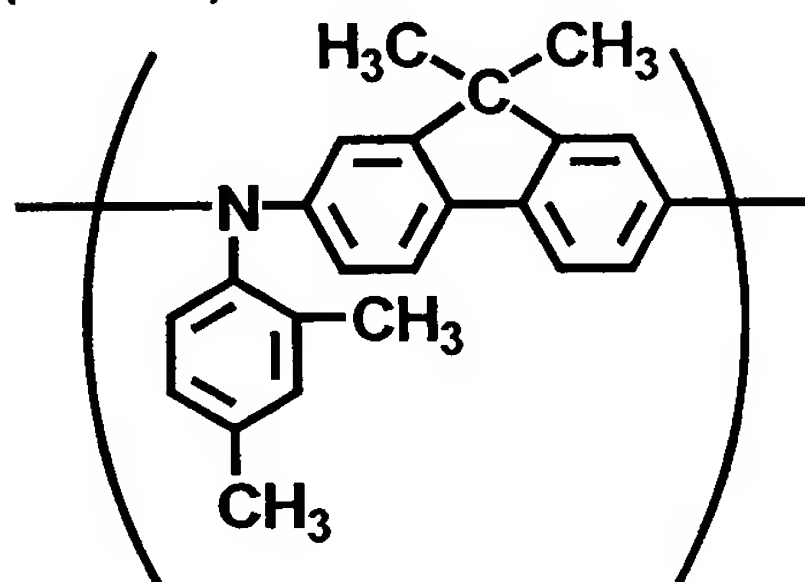
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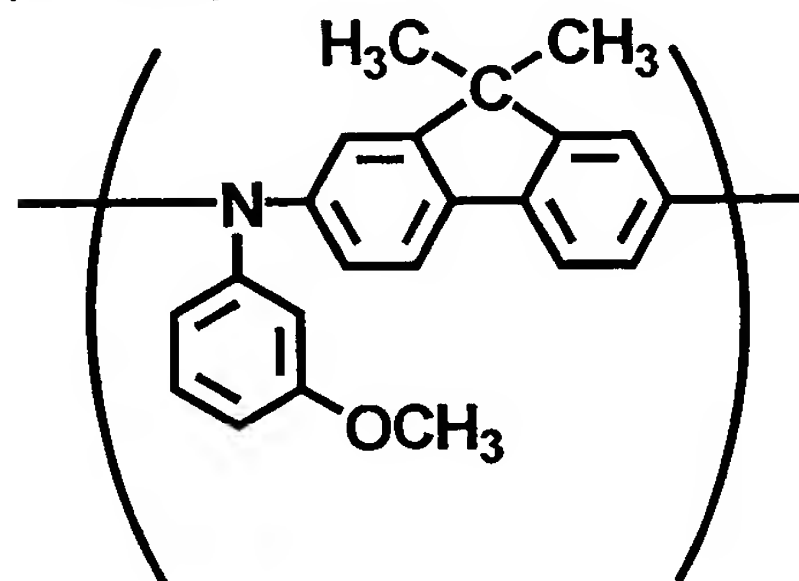
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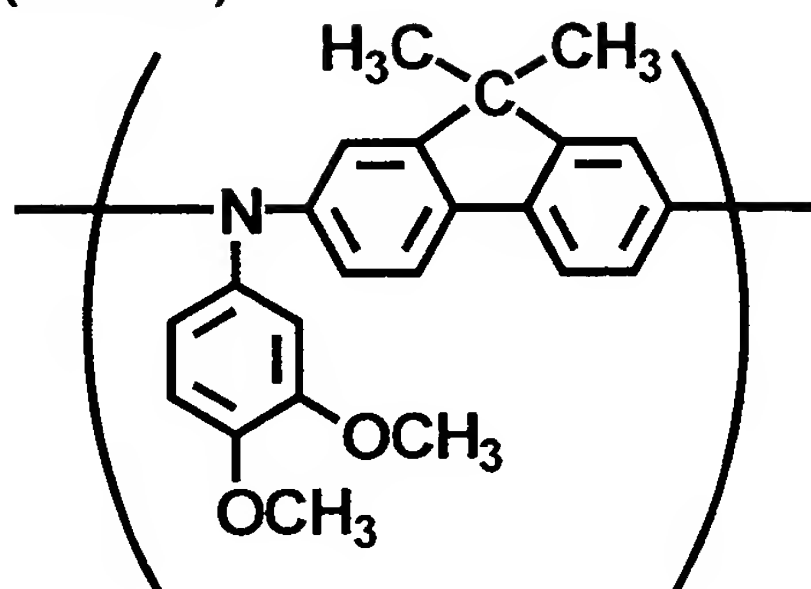
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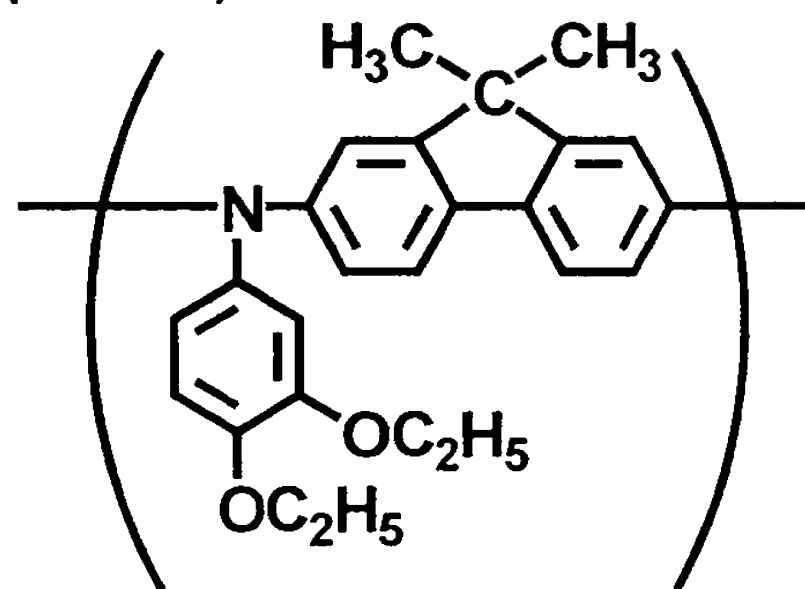
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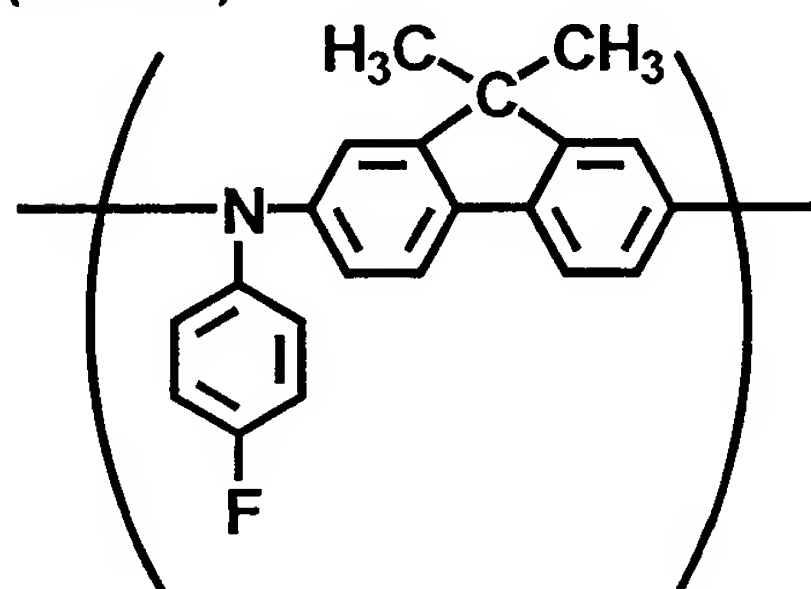
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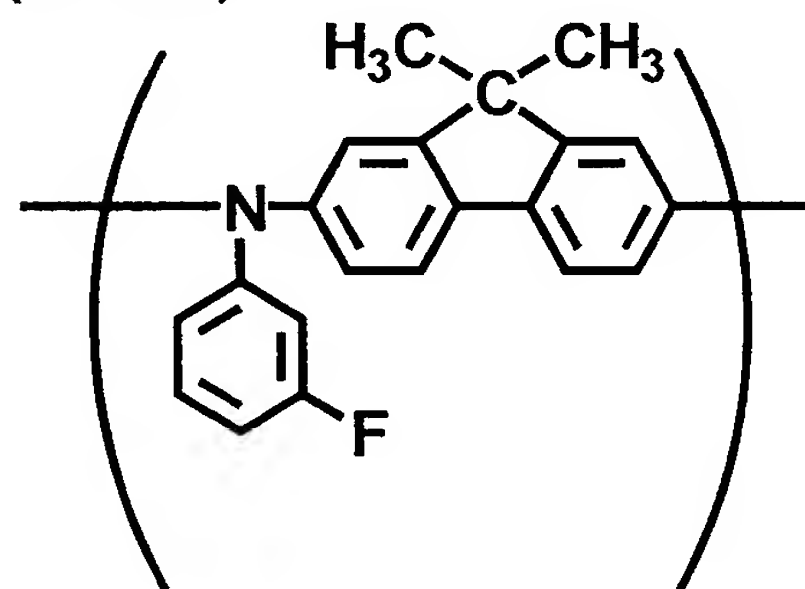
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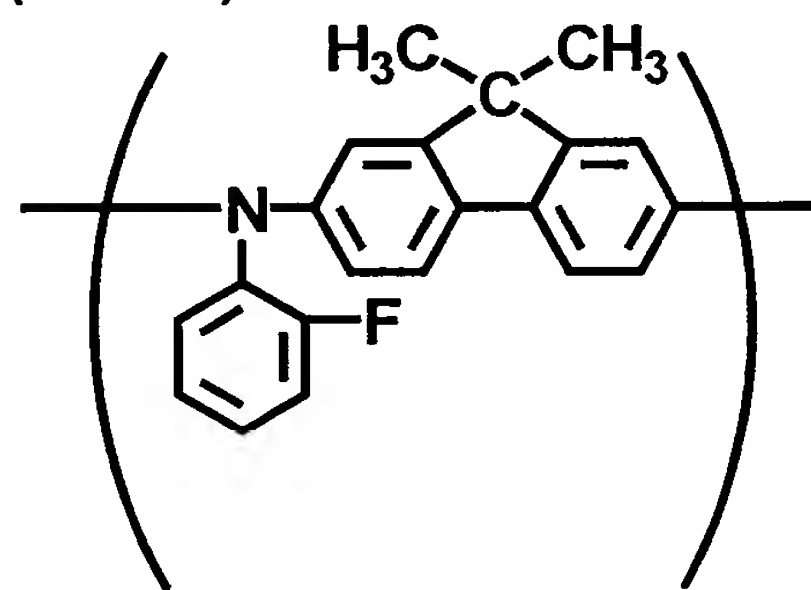
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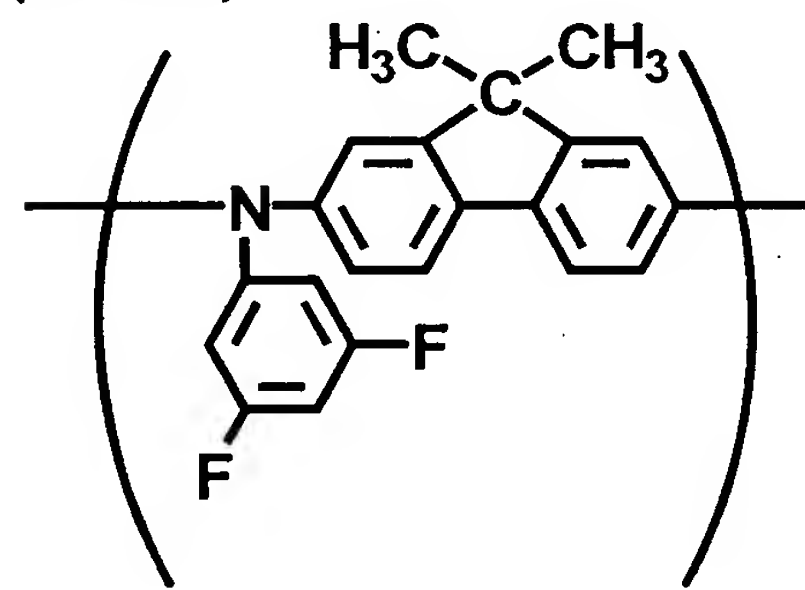
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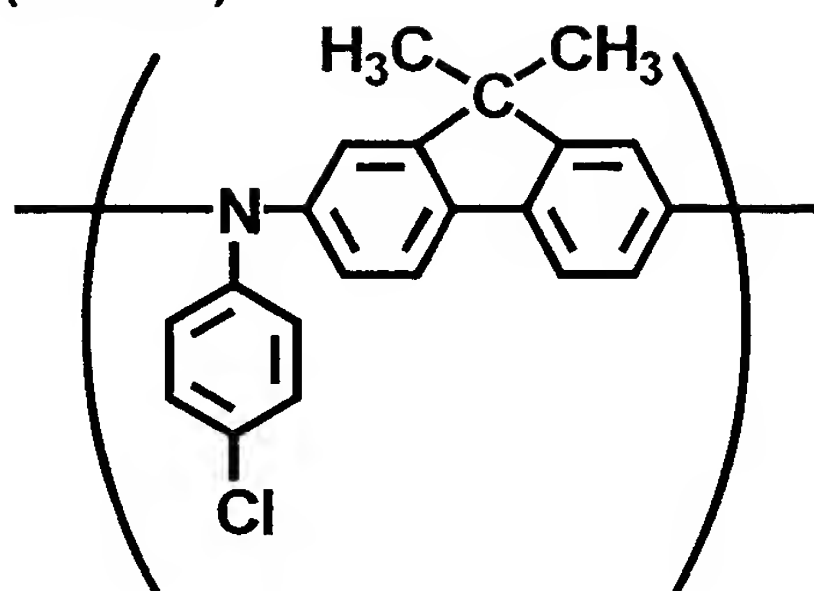
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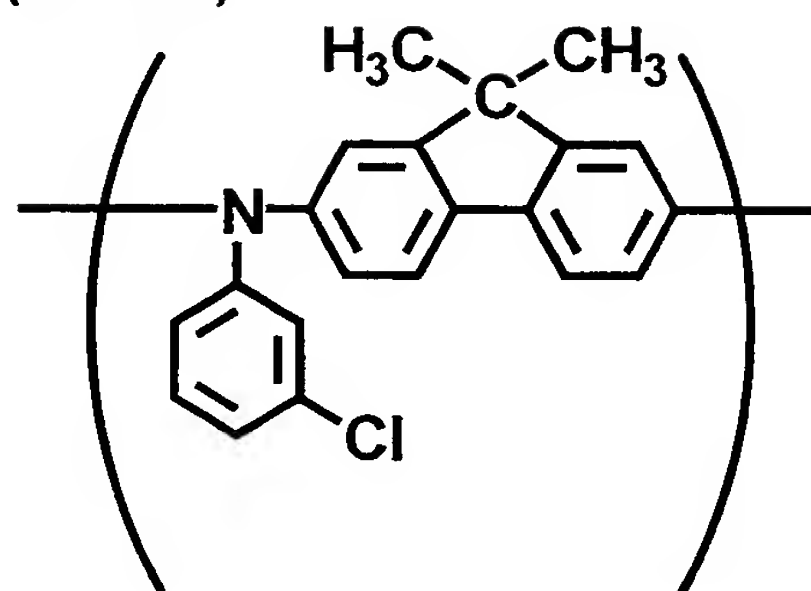
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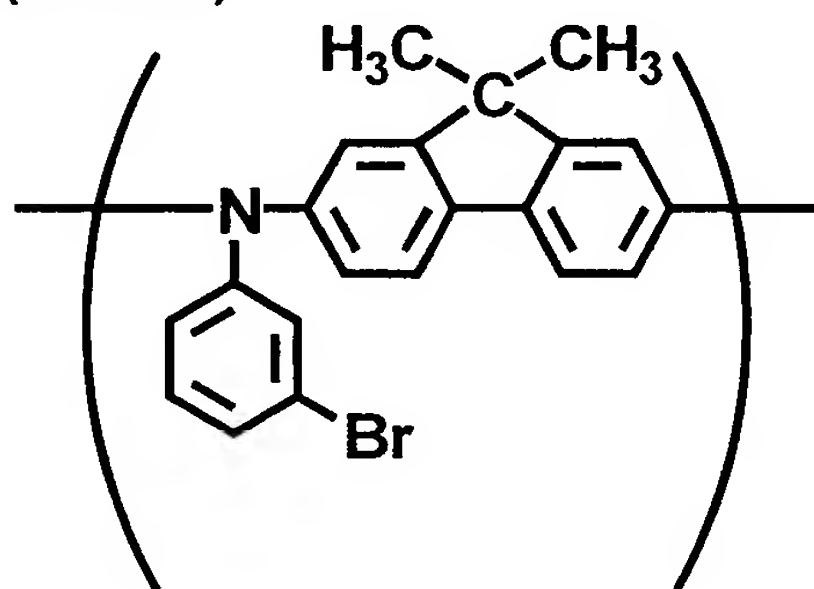
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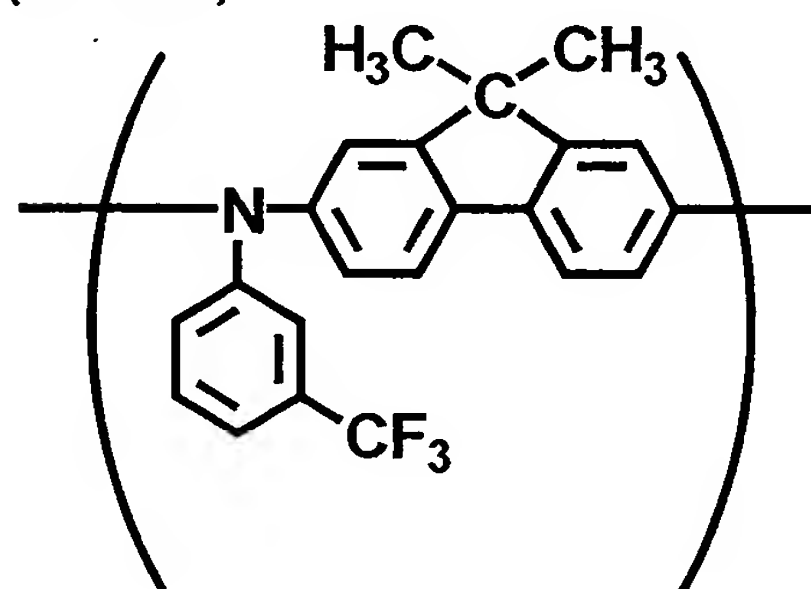
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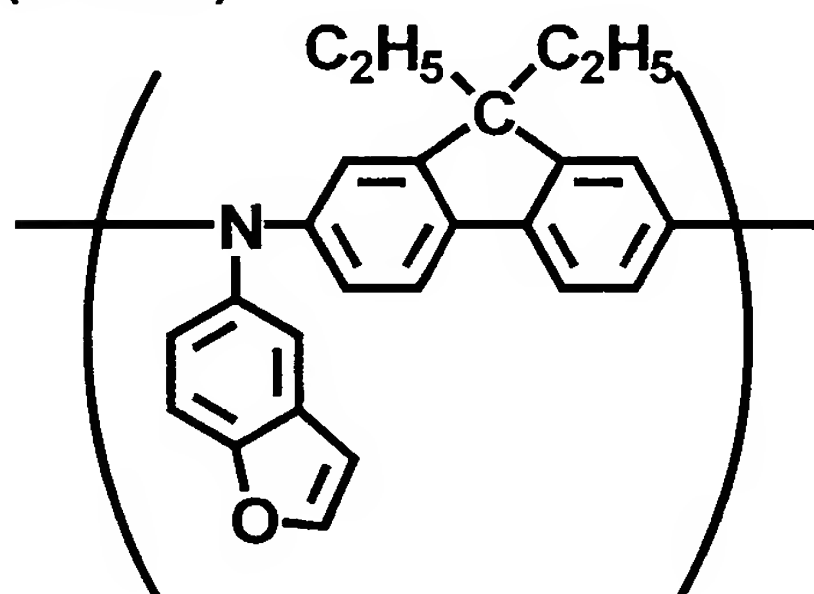
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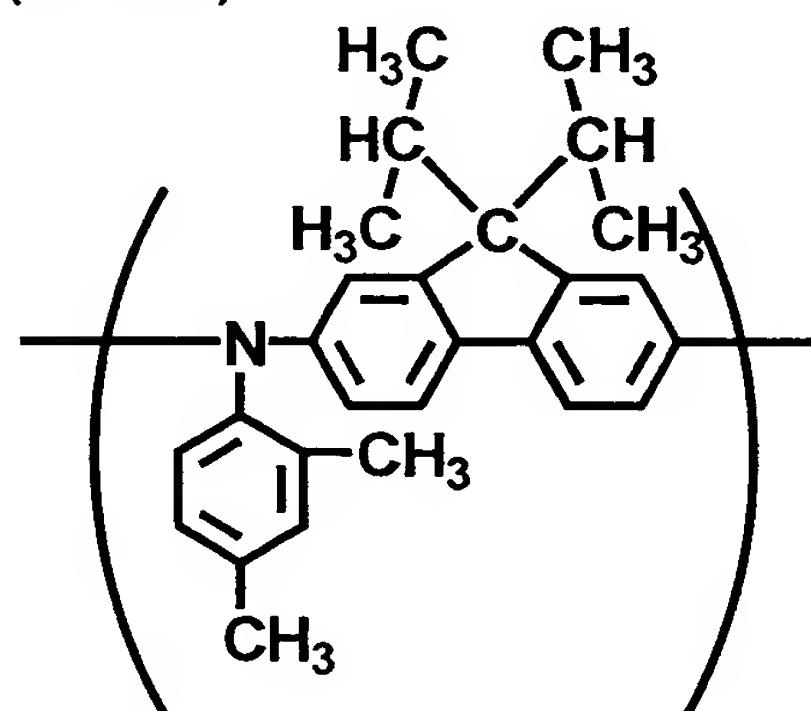
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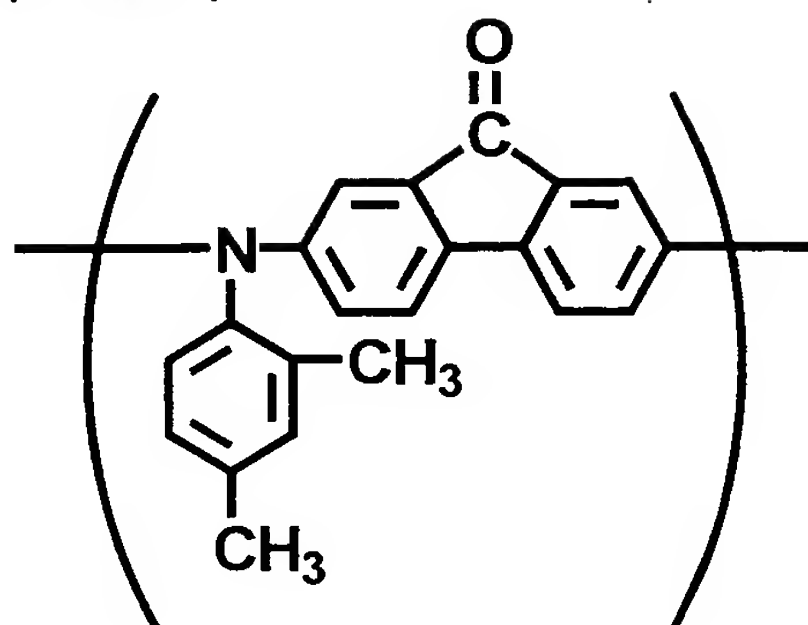
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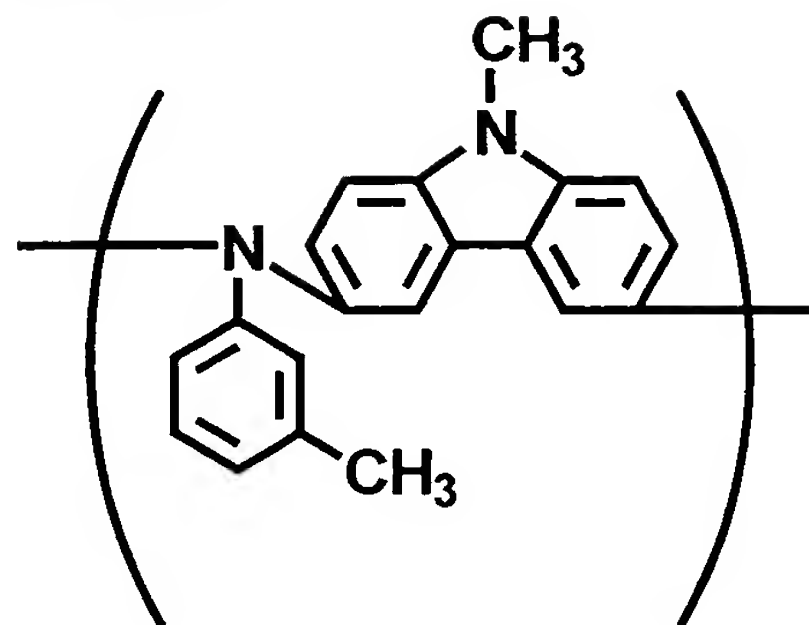
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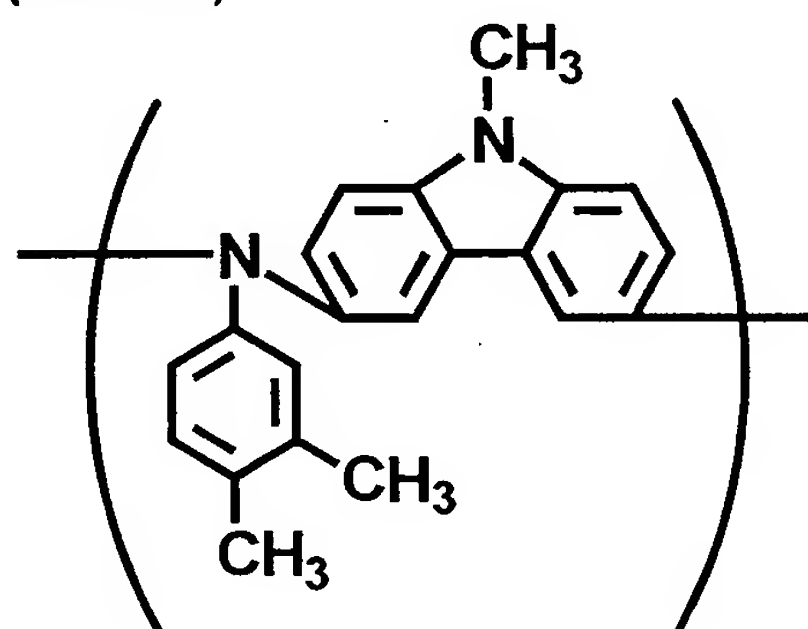
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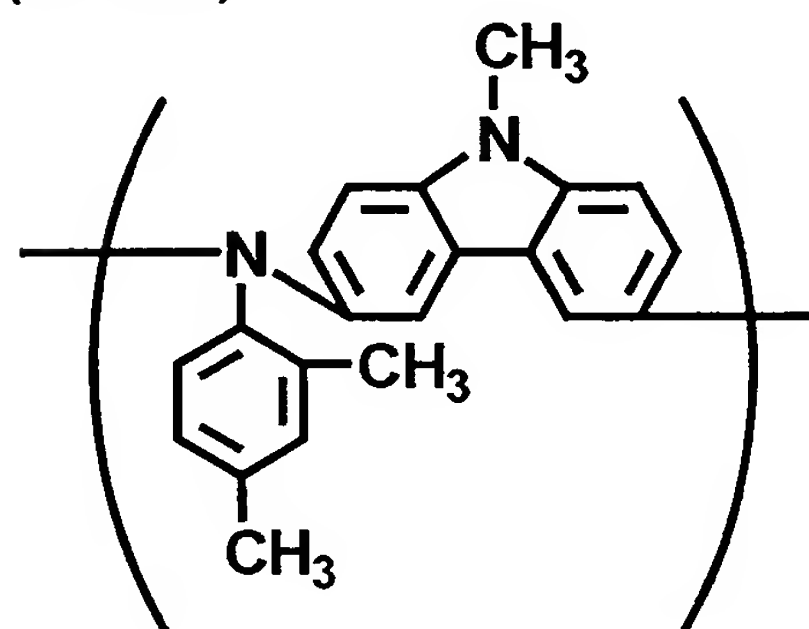
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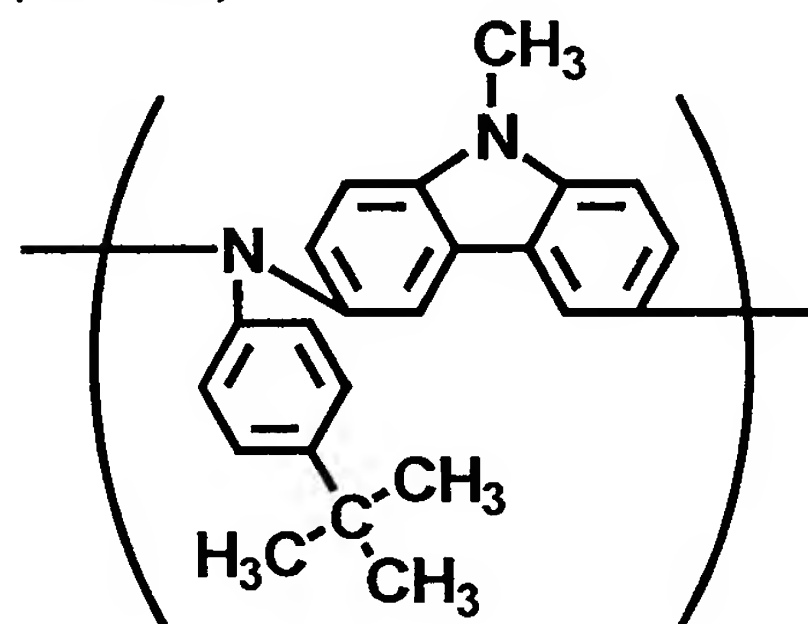
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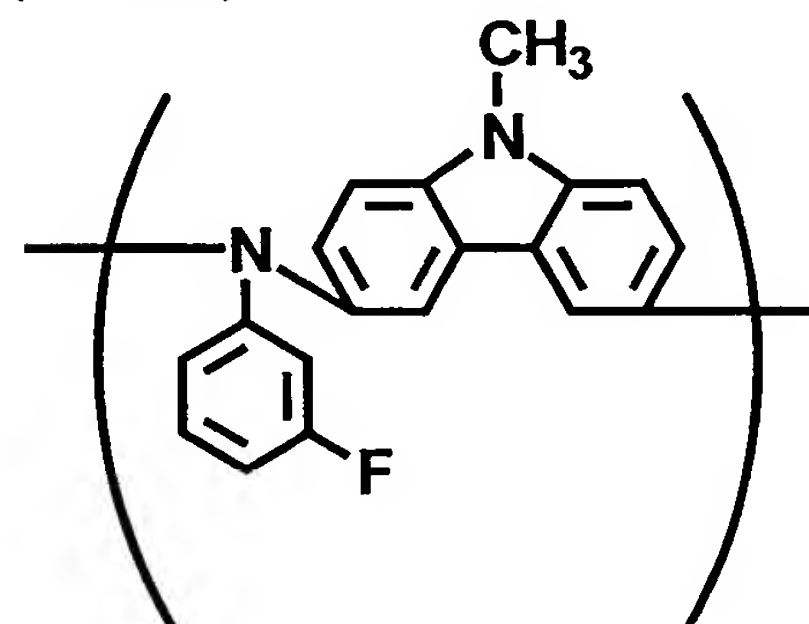
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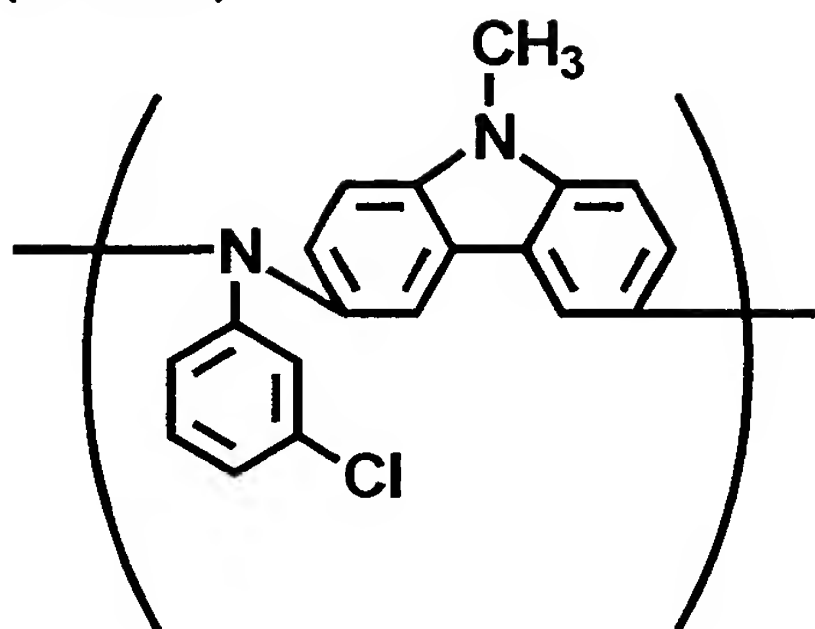
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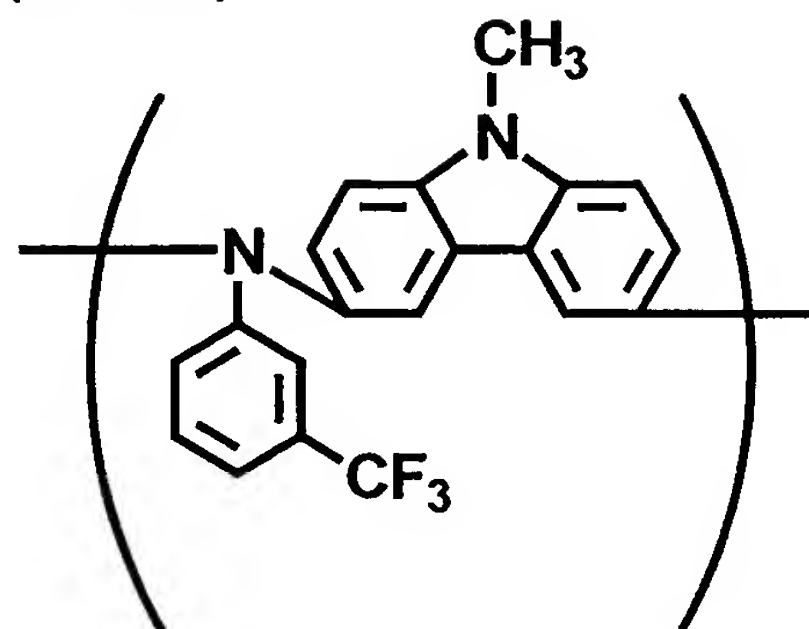
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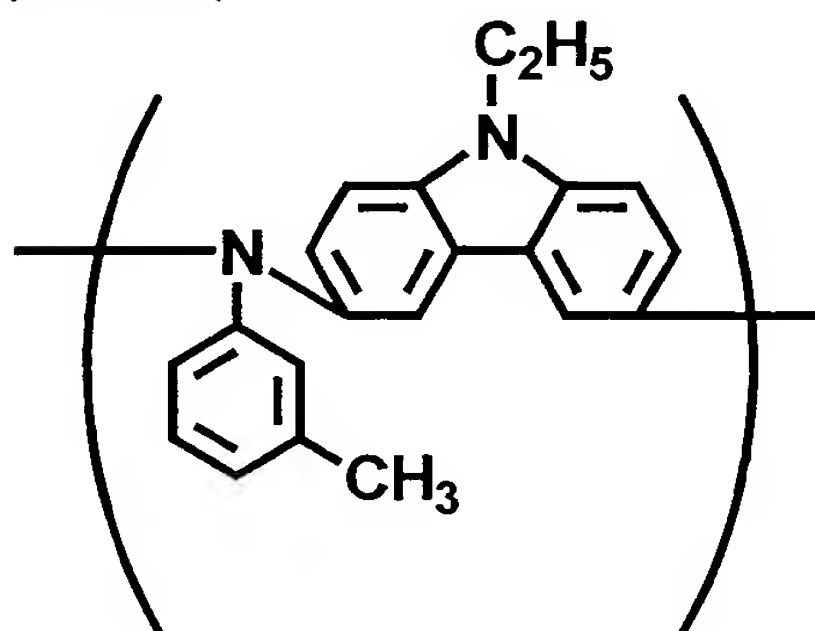
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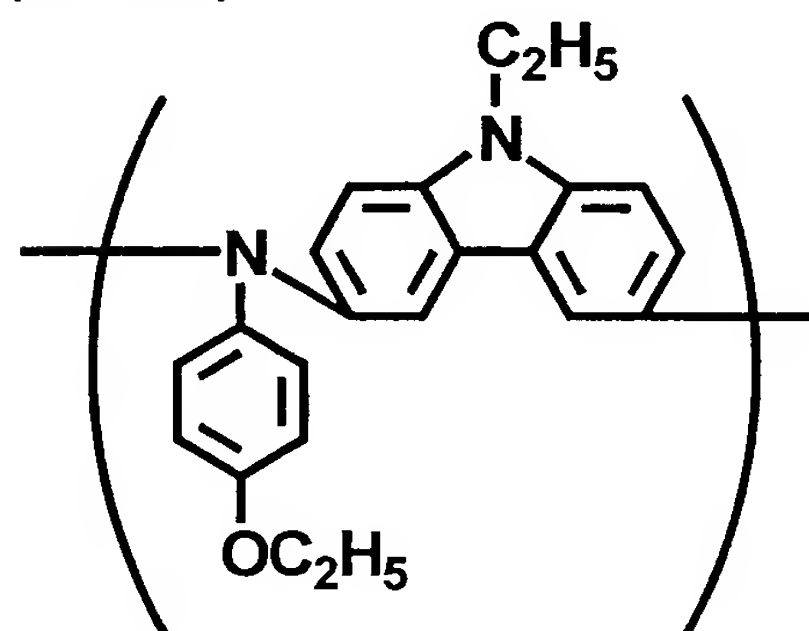
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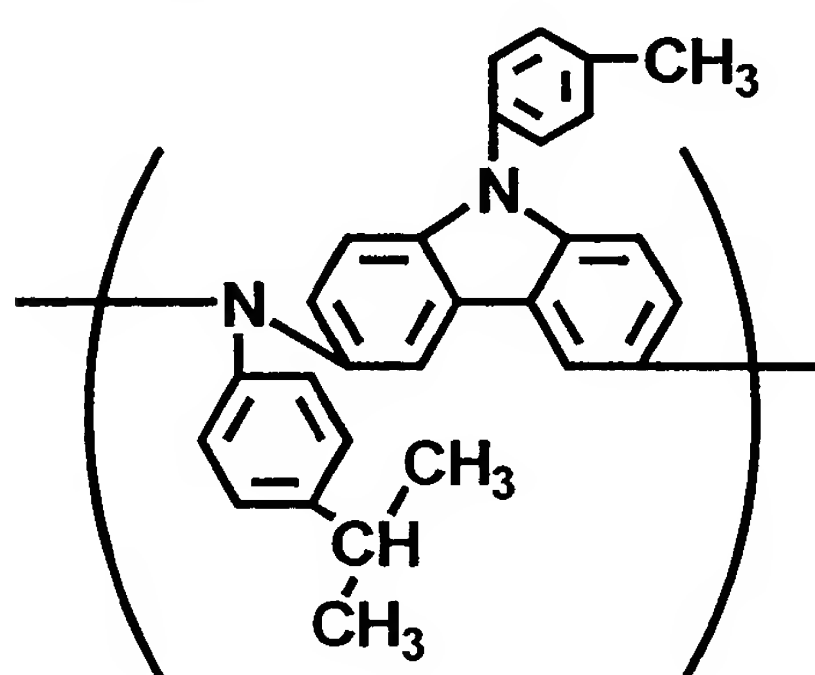
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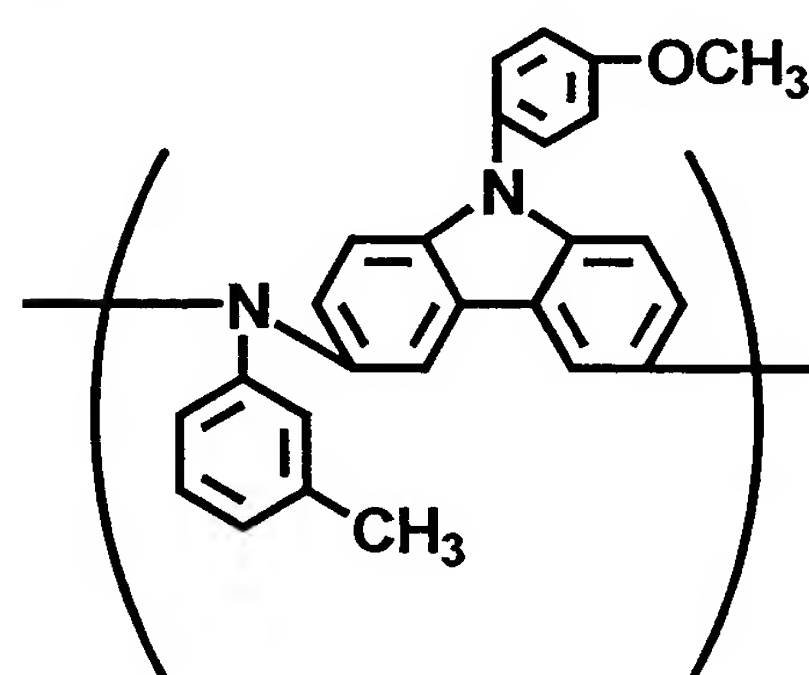
(CT-70)



(CT-71)

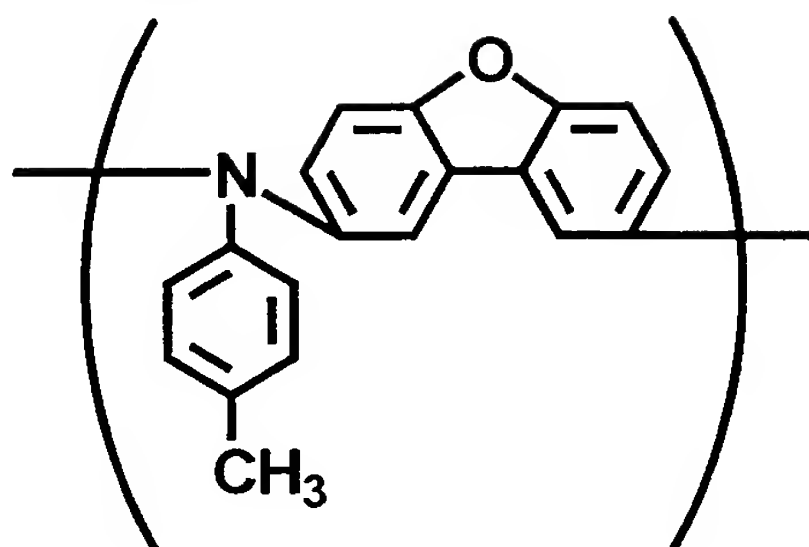


(CT-72)

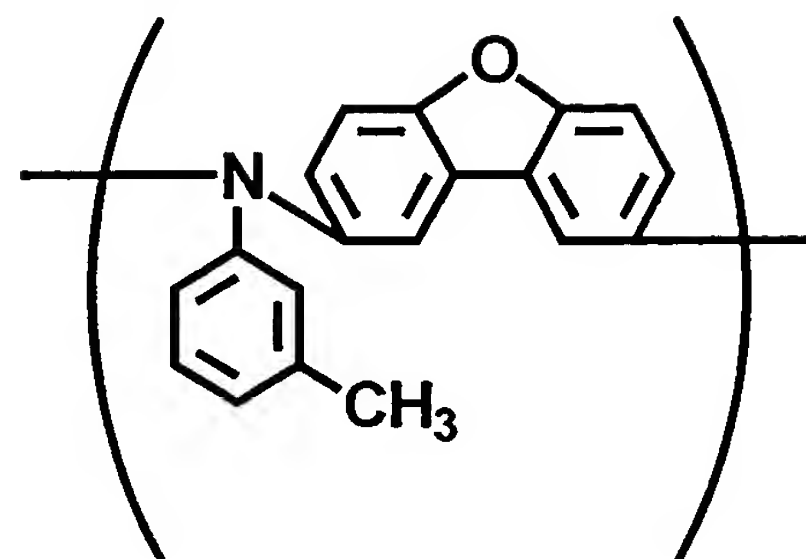




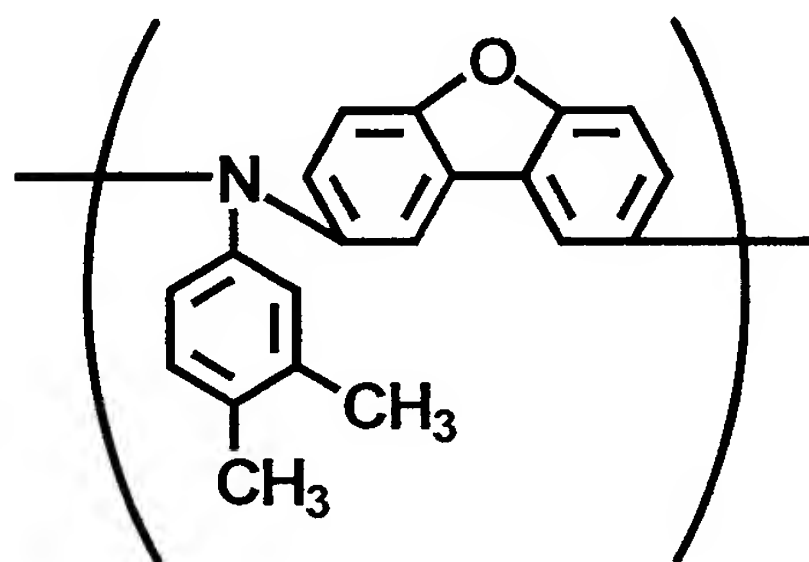
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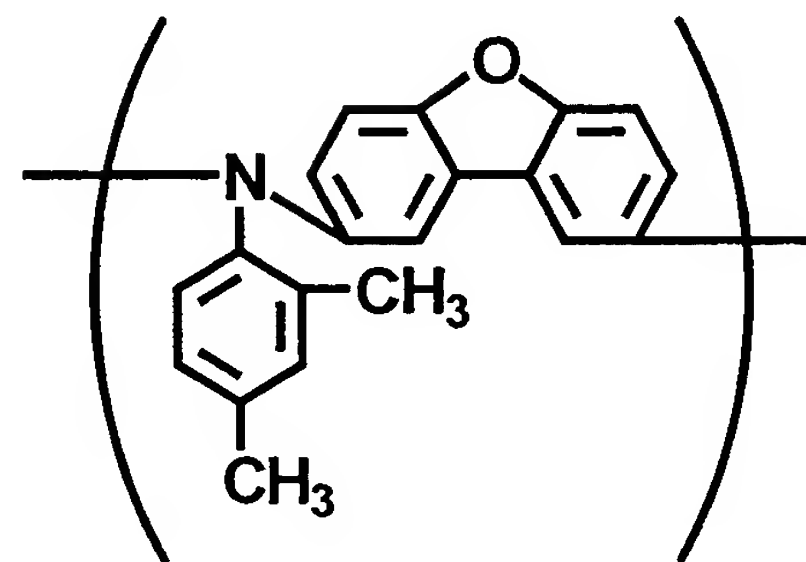
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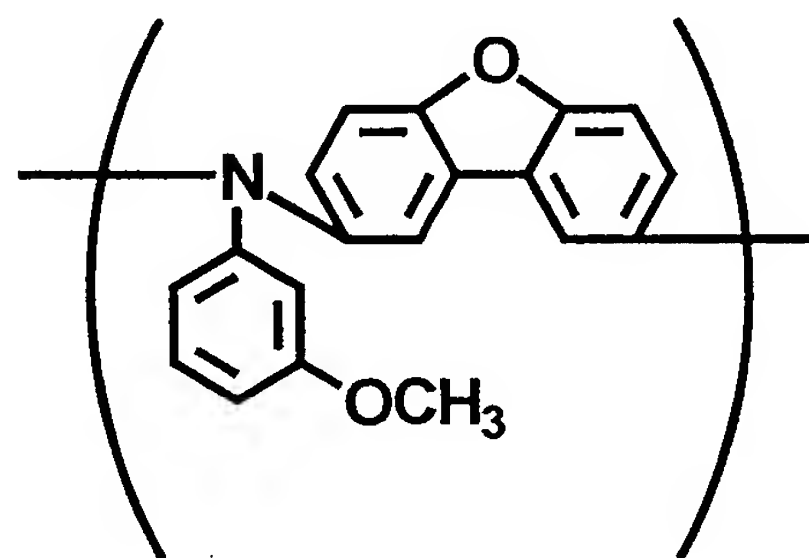
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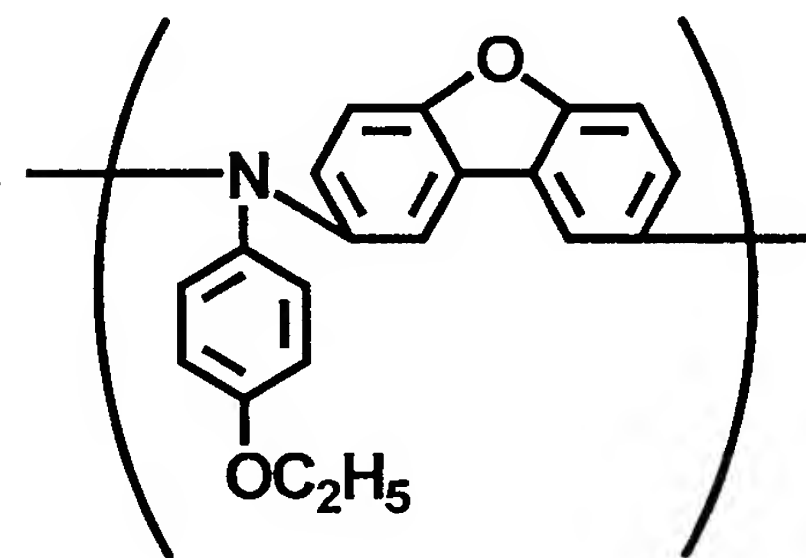
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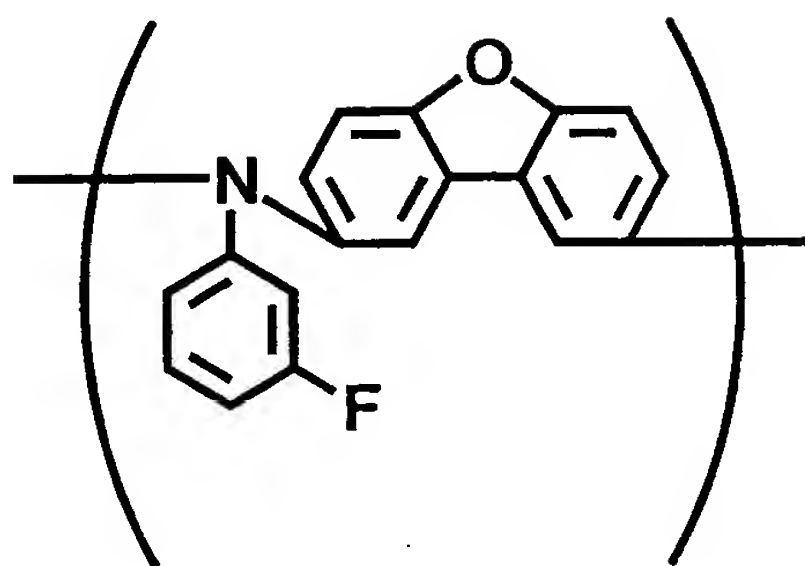
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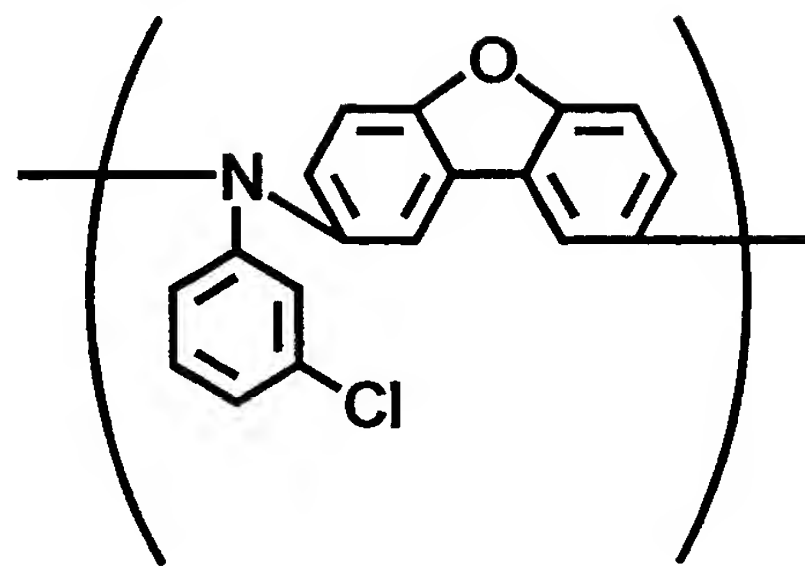
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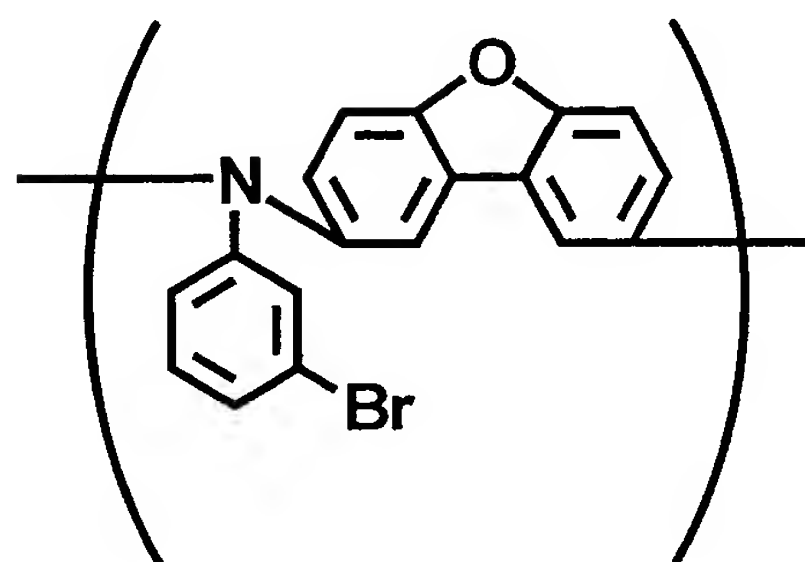
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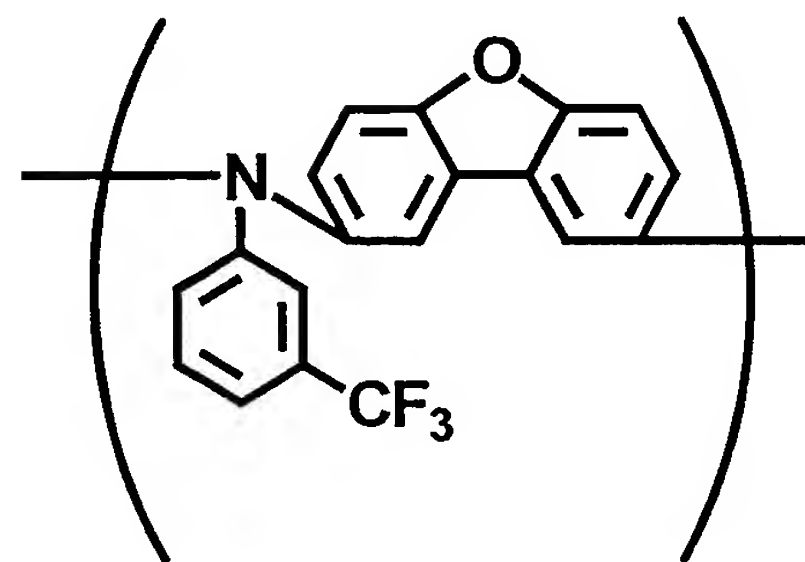
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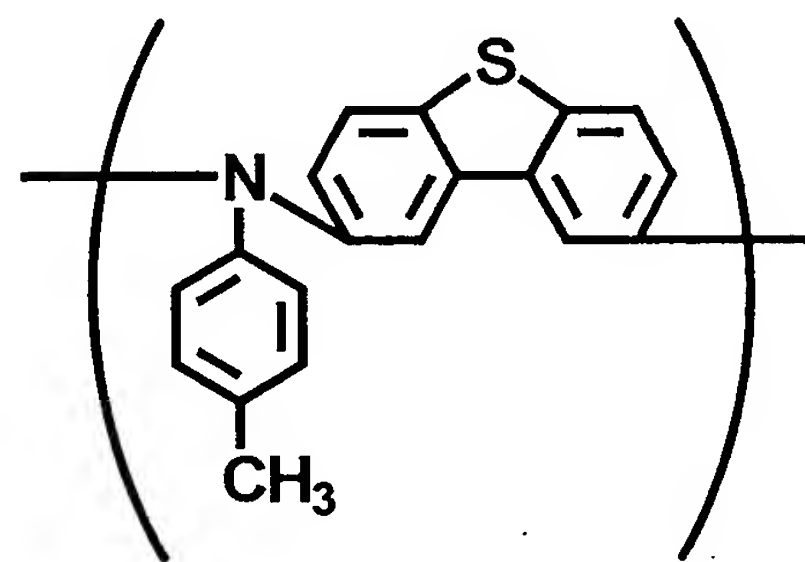
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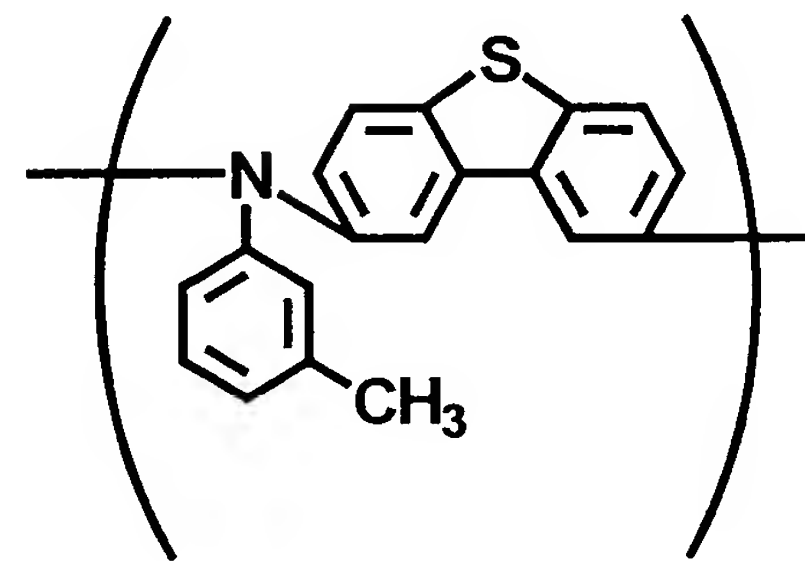
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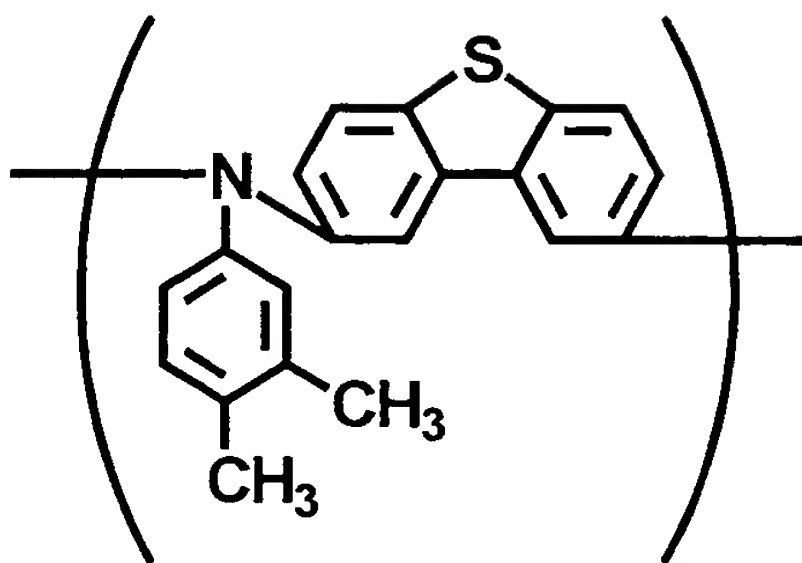
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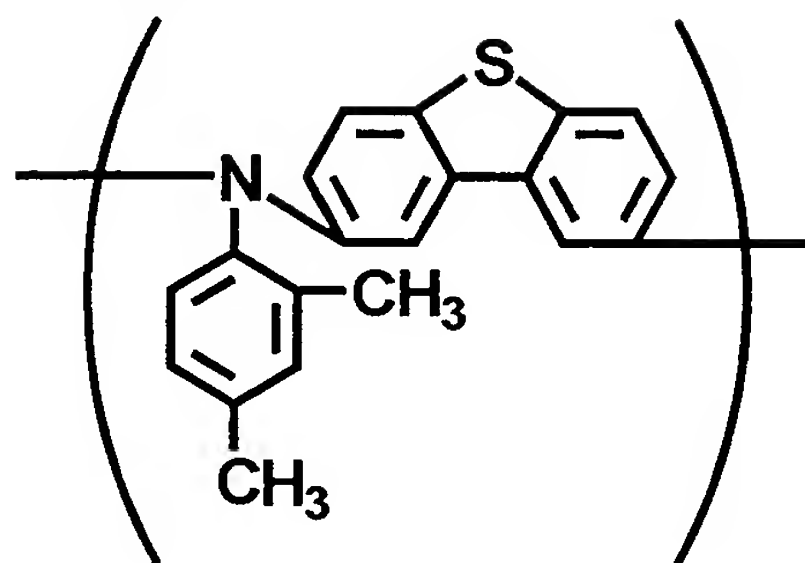
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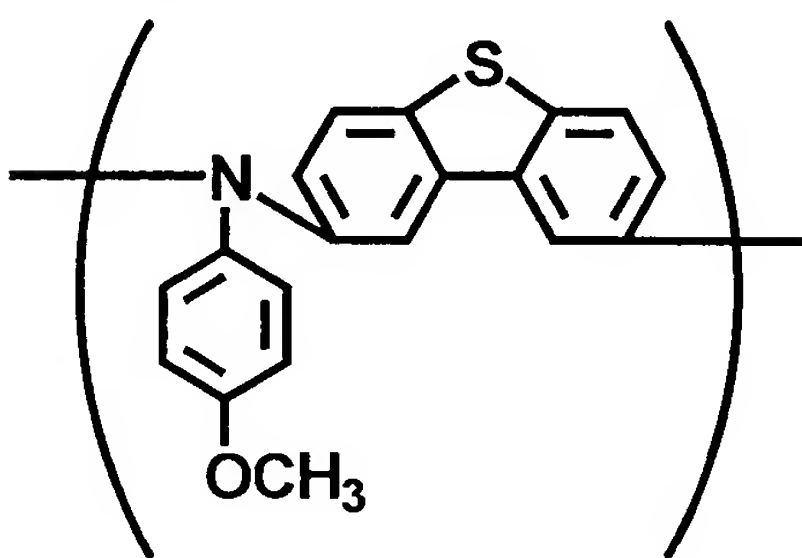
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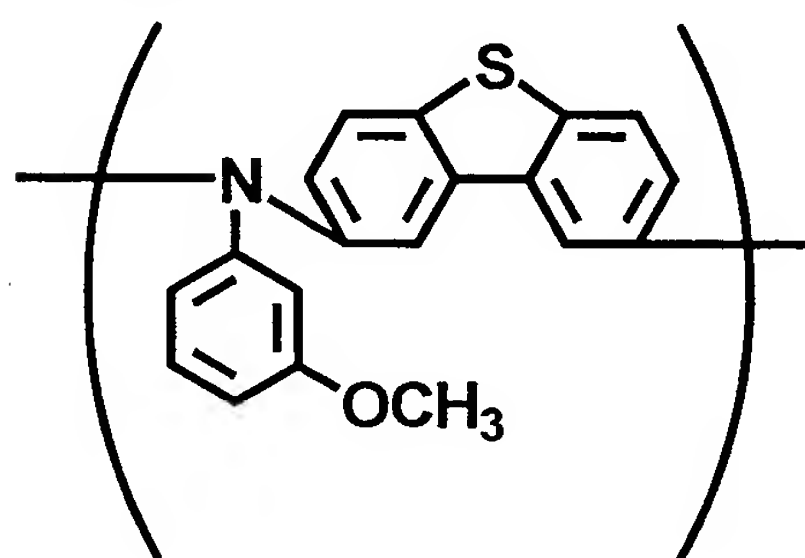
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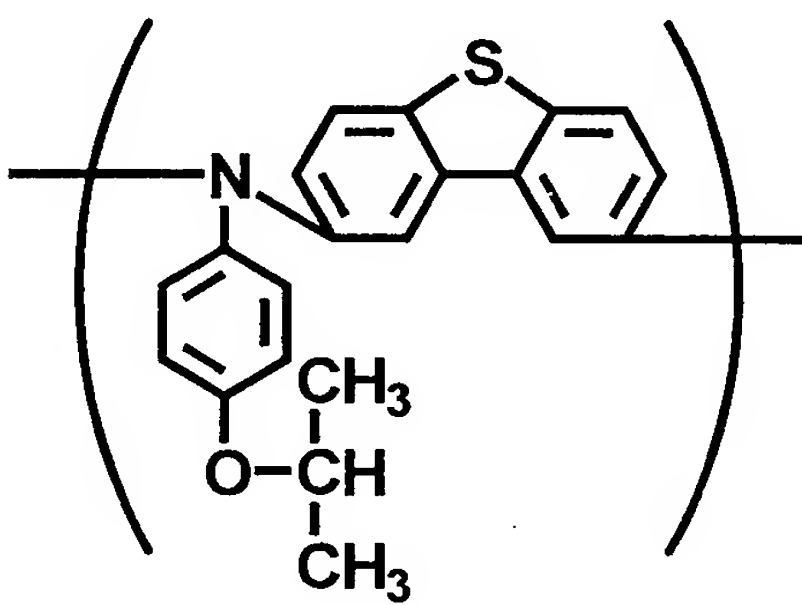
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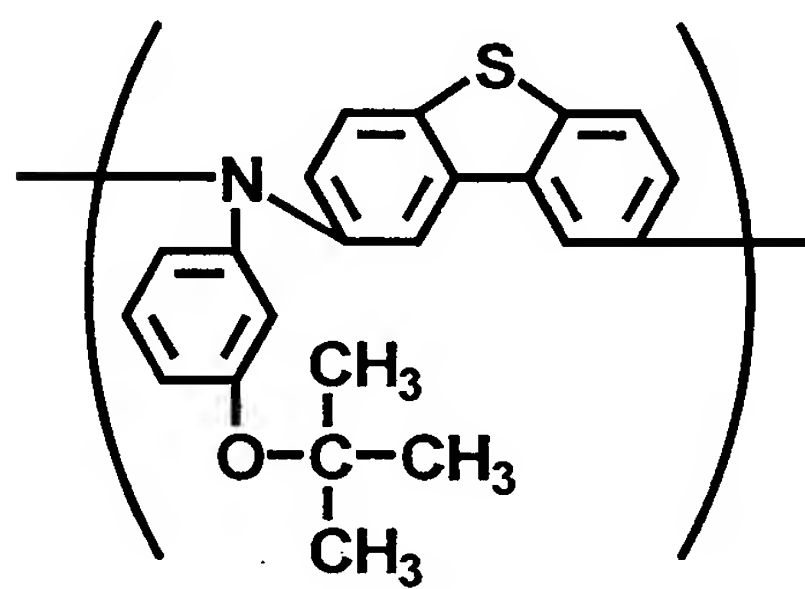
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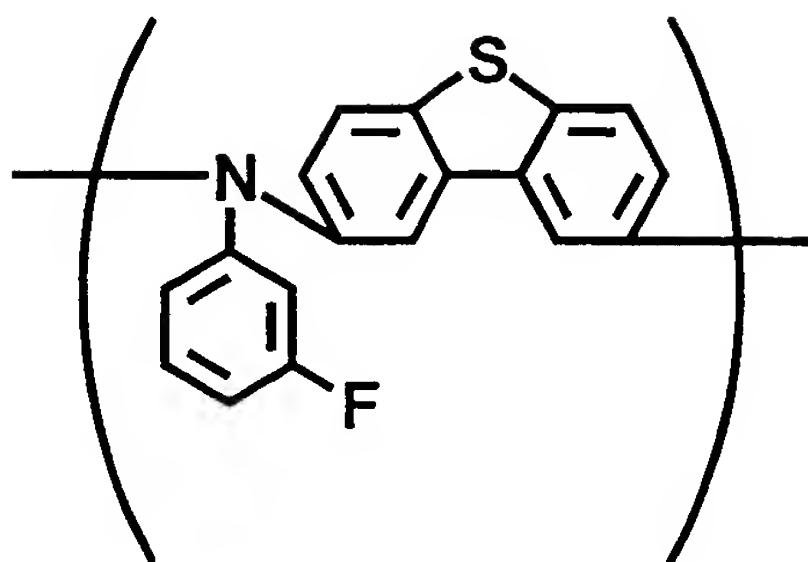
( CT-89 )



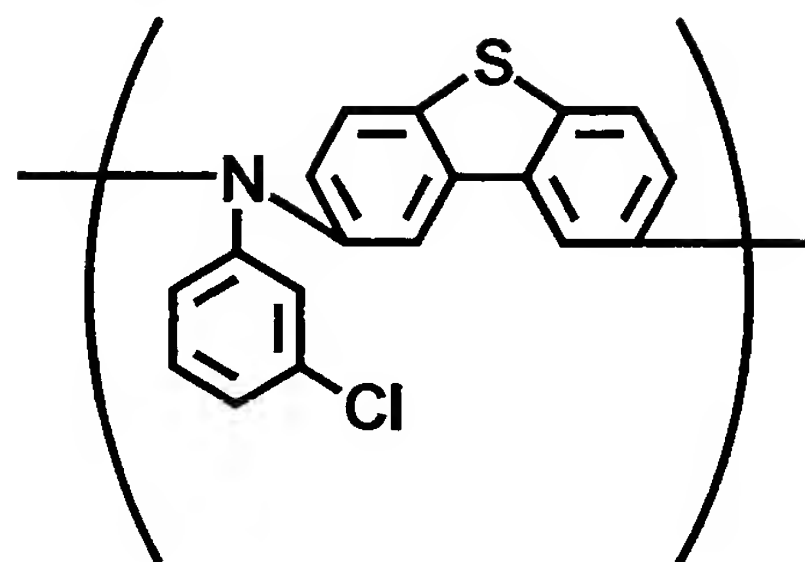
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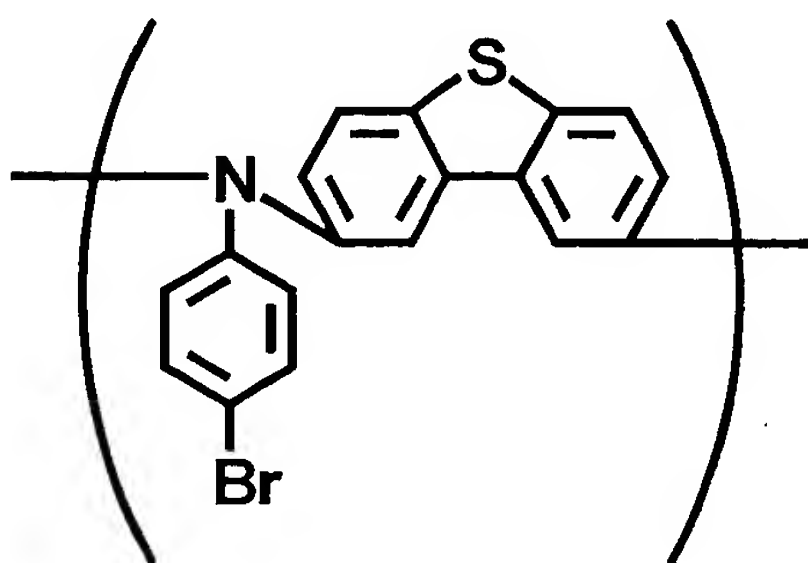
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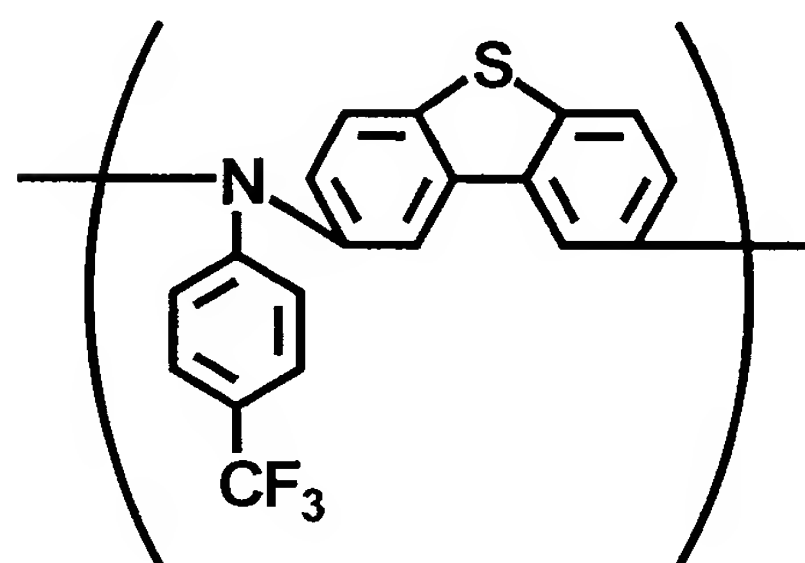
(CT-92)



(CT-93)



(CT-94)



Structural examples of the random-copolymer type high-molecular-weight charge-transporting material used in the present invention are shown in Tables 1 and 2  
5 below. The present invention is by no means limited to these.

Table 1

5	Structure	Repeating structural units		
		(1)	(2)	(3)
	CTP-1	CT-2	CT-45	-
10	CTP-2	CT-2	CT-64	-
	CTP-3	CT-2	CT-74	-
	CTP-4	CT-2	CT-84	-
15	CTP-5	CT-2	CT-84	-
	CTP-6	CT-4	CT-46	-
20	CTP-7	CT-4	CT-61	-
	CTP-8	CT-4	CT-76	-
	CTP-9	CT-4	CT-86	-
25	CTP-10	CT-5	CT-69	-
	CTP-11	CT-24	CT-73	-
30	CTP-12	CT-27	CT-91	-
	CTP-13	CT-48	CT-77	-
	CTP-14	CT-61	CT-83	-
35	CTP-15	CT-76	CT-86	-
	CTP-16	CT-79	CT-91	-
40	CTP-17	CT-2	CT-9	CT-76
	CTP-18	CT-2	CT-59	CT-90
	CTP-19	CT-4	CT-69	CT-74
45	CTP-20	CT-4	CT-70	CT-92

Table 2

	Structure	Repeating structural units		
		(1)	(2)	(3)
5	CTP-21	CT-2	CT-17	-
10	CTP-22	CT-2	CT-16	-
	CTP-23	CT-2	CT-9	-
	CTP-24	CT-2	CT-13	-
	CTP-25	CT-4	CT-17	-
15	CTP-26	CT-4	CT-8	-
	CTP-27	CT-4	CT-15	-
	CTP-28	CT-6	CT-20	-
	CTP-29	CT-24	CT-13	-
20	CTP-30	CT-29	CT-9	-
	CTP-31	CT-39	CT-43	-
	CTP-32	CT-45	CT-52	-
	CTP-33	CT-45	CT-56	-
25	CTP-34	CT-45	CT-57	-
	CTP-35	CT-2	CT-16	CT-48
	CTP-36	CT-2	CT-11	CT-60
	CTP-37	CT-4	CT-13	CT-52
30	CTP-38	CT-4	CT-12	CT-49

Of these, CTP-3, CTP-4, CTP-8, CTP-9, CTP-23, CTP-25, CTP-26, CTP-32 and CTP-33 are preferred, and CTP-8, CTP-9, CTP-23 and CTP-32 are more preferred.

5 The charge-transporting material incorporated in the surface layer of the electrophotographic photosensitive member of the present invention has a high molecular weight. Hence, it can prevent the surface layer from having a low film strength because of the addition of a charge-transporting material and can  
10 provide superior scratch resistance and wear resistance.

In addition, the charge-transporting material incorporated in the surface layer of the electrophotographic photosensitive member of the present invention is the copolymer having two or more kinds of  
15 repeating structural units. Hence, compared with homopolymers having single repeating structural units, the lowering of ionization potential of the charge-transporting material can be kept low, and the material can be tough even to the oxidation due to  
20 discharge and so forth and can be almost free of its deterioration due to repeated use. It has such characteristic features.

The random-copolymer type high-molecular-weight charge-transporting material used in the present  
25 invention also has an advantage that it enables easy control of solubility in solvents and compatibility with binder resins, compared with alternating copolymer type

and block copolymer type ones.

Only one kind of the random-copolymer type high-molecular-weight charge-transporting material described above or two or more kinds thereof may be used  
5 in the surface layer of the electrophotographic photosensitive member of the present invention.

The electrophotographic photosensitive member of the present invention is constructed as described below.

The electrophotographic photosensitive member of  
10 the present invention has the photosensitive layer on the support.

The photosensitive layer of the electrophotographic photosensitive member of the present invention may be either of a single-layer type  
15 photosensitive layer, in which a charge-generating material and a charge-transporting material are contained in the same layer, and a multi-layer type, which is functionally separated into a charge generation layer containing a charge-generating material and a  
20 charge transport layer containing a charge-transporting material. In view of electrophotographic performance, the multi-layer type is preferred.

The support may be any of those having a conductivity (conductive support), and may include  
25 supports made of metal such as aluminum or stainless steel, and supports made of metal, paper or plastic on which a layer providing conductivity is formed. As the



shape of the support, it may be in the shape of a cylinder, a belt or the like.

Where laser light is used in imagewise exposure, a conductive layer may be provided on the support for the purpose of preventing interference fringes due to light scattering or for the purpose of covering any scratches of the support. The conductive layer may be formed of a binder resin in which conductive particles such as carbon black and metal particles have been dispersed. The conductive layer may preferably have a layer thickness of from 5  $\mu\text{m}$  to 40  $\mu\text{m}$ , and particularly more preferably from 10  $\mu\text{m}$  to 30  $\mu\text{m}$ . Incidentally, the interference fringes may also be prevented by treating the surface of the support by cutting, anodizing, dry-process blasting, wet-process blasting or the like.

Between the support or conductive layer and the photosensitive layer, an intermediate layer may also be provided which has the function of bonding or the function as a barrier. To form the intermediate layer, a resin such as polyamide, polyvinyl alcohol, polyethylene oxide, ethyl cellulose, casein, polyurethane or polyether-urethane may be dissolved in a suitable solvent, and the resulting solution may be coated on the support or conductive layer, followed by drying. The intermediate layer may preferably have a layer thickness of from 0.05  $\mu\text{m}$  to 5  $\mu\text{m}$ , and particularly more preferably from 0.3  $\mu\text{m}$  to 1  $\mu\text{m}$ .

On the support, conductive layer or intermediate layer, the photosensitive layer is provided.

The multi-layer type photosensitive layer, which is functionally separated into a charge generation layer  
5 containing a charge-generating material and a charge transport layer containing a charge-transporting material, is described first.

The charge-generating material may include selenium-tellurium dyes, pyrylium dyes, thiapyrylium  
10 dyes, phthalocyanine pigments, anthanthrone pigments, dibenspirenequinone pigments, trisazo pigments, cyanine pigments, azo (trisazo, disazo and monoazo) pigments, indigo pigments, quinacridone pigments and asymmetric quinocyanine pigments.

15 To form the charge generation layer, the charge-generating material may be well dispersed together with a 0.3 to 4-fold quantity of binder resin and a suitable solvent by means of a homogenizer, an ultrasonic dispersion machine, a ball mill, a vibrating  
20 ball mill, a sand mill, an attritor, a roll mill, a liquid impact type high-speed dispersion machine or the like, and the dispersion obtained may be coated, followed by drying. Incidentally, the binder resin may be introduced after the charge-generating material has  
25 been dispersed, or the binder resin may be not used if the charge-generating material has film-forming properties. The charge generation layer may preferably

have a layer thickness of 5  $\mu\text{m}$  or less, and particularly more preferably from 0.1  $\mu\text{m}$  to 2  $\mu\text{m}$ .

Where the charge transport layer is the surface layer of the electrophotographic photosensitive member,  
5 the charge-transporting material used in such a charge transport layer is the above random-copolymer type high-molecular-weight charge-transporting material of the present invention.

To form the surface layer charge transport layer,  
10 the random-copolymer type high-molecular-weight charge-transporting material and the electrically insulating binder resin may be dissolved with a solvent, and the coating solution obtained may be coated, followed by drying. The charge transport layer may  
15 preferably have a layer thickness of from 5  $\mu\text{m}$  to 40  $\mu\text{m}$ , more preferably from 10  $\mu\text{m}$  to 35  $\mu\text{m}$ s, and still more preferably from 15  $\mu\text{m}$  to 30  $\mu\text{m}$ .

The random-copolymer type high-molecular-weight charge-transporting material and the electrically  
20 insulating binder resin may preferably be in a weight ratio of from 2:1 to 1:10, more preferably from 1:1 to 1:8, and still more preferably from 1:2 to 1:4.

The electrically insulating binder resin may be any of electrically insulating binder resins commonly  
25 used in electrophotographic photosensitive members. In particular, polycarbonate resins and polyarylate resins are especially favorable in order to bring out the

effect of the present invention.

The polycarbonate resins and the polyarylate resins are both obtainable by conventional methods. In particular, a polycarbonate resin obtained by  
5 polycondensation using bisphenol and phosgene and a polyarylate resin obtained by polycondensation using bisphenol and a dicarboxylic-acid chloride are preferred because electrophotographic performance such as sensitivity can be improved in view of purity as being,  
10 e.g., residue-free and also because mechanical properties such as mechanical strength can be improved in view of molecular weight and molecular weight distribution.

The polycarbonate resin may preferably have a  
15 weight-average molecular weight  $M_w$  in the range of from 40,000 to 200,000, and the polyarylate resin may preferably have a weight-average molecular weight  $M_w$  in the range of from 40,000 to 200,000.

A low-molecular-weight charge-transporting  
20 material may also be used in combination as long as the effect of the present invention is not damaged. From the viewpoint that the effect of the present invention is not damaged, structures having charge transport performance of the random-copolymer type  
25 high-molecular-weight charge-transporting material (e.g., the repeating structural unit represented by the above Formula (11) and the repeating structural units

represented by the above Formula (12)) may preferably be in a proportion of 50 mol% or more, and still more preferably 70 mol% or more, based on the whole structures having charge transport performance (i.e.,  
5 the sum of the repeating structural units and the low-molecular-weight charge-transporting material). The low-molecular-weight charge-transporting material may include, e.g., triarylamine compounds, hydrazone compounds, stilbene compounds, pyrazoline compounds,  
10 oxazole compounds, triallylmethane compounds and thiazole compounds.

Where the photosensitive layer is the single-layer type photosensitive layer and the single-layer type photosensitive layer is the surface layer of the  
15 electrophotographic photosensitive member, the single-layer type photosensitive layer may be formed by dissolving or dispersing the charge-generating material, the random-copolymer type high-molecular-weight charge-transporting material and so forth in the  
20 electrically insulating binder resin, and coating the resulting dispersion, followed by drying. The single-layer type photosensitive layer may preferably have a layer thickness of from 5  $\mu\text{m}$  to 40  $\mu\text{m}$ , and more preferably from 15  $\mu\text{m}$  to 30  $\mu\text{m}$ .

25 For the purpose of protecting the photosensitive layer, a protective layer may also be provided on the photosensitive layer, and this may be made to serve as

the surface layer.

The protective layer serving as the surface layer of the electrophotographic photosensitive member may be formed by dissolving the random-copolymer type  
5 high-molecular-weight charge-transporting material and the electrically insulating binder resin in a suitable solvent, and coating the resulting coating solution on the photosensitive layer, followed by drying. The protective layer may preferably have a layer thickness  
10 of from 0.05  $\mu\text{m}$  to 20  $\mu\text{m}$ .

A lubricant for providing lubricity (slipperiness) or a filler for improving mechanical strength may also be added to the surface layer of the electrophotographic photosensitive member of the present invention.

15 When the above respective layers are formed, they may be formed by any coating method including dip coating, spray coating, spinner coating, blade coating and roll coating.

In the present invention, the weight-average  
20 molecular weight  $M_w$  is measured in the following way.

Measurement of weight-average molecular weight  $M_w$ :

The weight-average molecular weight is measured by a conventional method, using a gel permeation chromatography (GPC) apparatus (trade name: HLC8120GPC;  
25 manufactured by Tosoh Corporation).

A measurement target sample is put in THF (tetrahydrofuran), and is left to stand for several

hours, followed by thorough shaking so as to be well mixed with the THF (until coalescent matter of the sample has disappeared), which is further left to stand for at least 12 hours. Thereafter, the solution having  
5 been passed through a sample-treating filter (trade name: MAISHORIDISK H-25-5; available from Tosoh Corporation; pore size: 0.45 to 0.5  $\mu\text{m}$ ) is used as the sample for GPC. The sample is so prepared that the measurement target sample is in a concentration of from  
10 0.5 to 5 mg/ml.

Using the sample for GPC thus prepared, the weight-average molecular weight of the measurement target sample is measured in the following way.

Columns are stabilized in a heat chamber of 40°C.  
15 To the columns kept at this temperature, THF as a solvent is flowed at a flow rate of 1 ml per minute, and about 10  $\mu\text{l}$  of the sample for GPC is injected thereinto to make measurement.

In measuring the molecular weight of the  
20 measurement target sample, the molecular weight distribution the measurement target sample has is calculated from the relationship between the logarithmic value of a calibration curve prepared using several kinds of monodisperse polystyrene standard samples and  
25 the count number.

As the standard polystyrene samples used for preparing the calibration curve, 10 standard polystyrene

samples with molecular weights of from  $10^2$  to  $10^7$  are used, which are available from Tosoh Corporation.

An RI (refractive index) detector is used as a detector.

5       As the columns, TSKgel series are used, which are available from Tosoh Corporation.

Figure schematically illustrates the construction of an electrophotographic apparatus provided with a process cartridge having the electrophotographic  
10       photosensitive member of the present invention.

In Figure, reference numeral 1 denotes a drum-shaped electrophotographic photosensitive member of the present invention, which is rotatingly driven around an axis 2 in the direction of an arrow at a stated  
15       peripheral speed.

The electrophotographic photosensitive member 1 is, being rotatingly driven, uniformly electrostatically charged on its peripheral surface to a positive or negative, given potential through a charging means  
20       (primary charging means) 3. The electrophotographic photosensitive member thus charged is then exposed to exposure light (imagewise exposure light) 4 emitted from an exposure means (not shown) for slit exposure or laser beam scanning exposure. In this way, electrostatic  
25       latent images corresponding to the intended image information are successively formed on the peripheral surface of the electrophotographic photosensitive member



1.

The electrostatic latent images thus formed on the peripheral surface of the electrophotographic photosensitive member 1 are developed with toner by the operation of a developing means 5. The toner images thus formed and held on the peripheral surface of the electrophotographic photosensitive member 1 are then successively transferred by the aid of transfer bias applied from a transfer means (transfer roller) 6, to a transfer material (such as paper) P taken out and fed from a transfer material feed means (not shown) to the part (contact part) between the electrophotographic photosensitive member 1 and the transfer means 6 in the manner synchronized with the rotation of the electrophotographic photosensitive member 1.

The transfer material P onto which the toner images have been transferred is separated from the peripheral surface of the electrophotographic photosensitive member, is led through a fixing means 8, where the toner images are fixed, and is then put out of the apparatus as an image-formed material (a print or copy).

The peripheral surface of the electrophotographic photosensitive member 1 from which images have been transferred is brought to removal of transfer residual toner through a cleaning means (cleaning blade) 7. Thus, its surface is cleaned. The electrophotographic

photosensitive member is further subjected to charge elimination by pre-exposure light (not shown) emitted from a pre-exposure means (not shown), and then repeatedly used for the formation of images.

- 5 Incidentally, where the charging means 3 is a contact charging means making use of a charging roller or the like as shown in Figure, the pre-exposure is not necessarily required.

The apparatus may be constituted of a combination  
10 of plural components integrally joined in a container as a process cartridge from among the constituents such as the above electrophotographic photosensitive member 1, charging means 3, developing means 5, transfer means 6 and cleaning means 7 so that the process cartridge is  
15 detachably mountable to the main body of an electrophotographic apparatus such as a copying machine or a laser beam printer. In the apparatus shown in Figure, the electrophotographic photosensitive member 1, the primary charging means 3, the developing means 5 and  
20 the cleaning means 7 are integrally supported in a cartridge to form a process cartridge 9 that is detachably mountable to the main body of the electrophotographic apparatus through a guide means 10 such as rails provided in the main body of the  
25 electrophotographic apparatus.

The effect of the present invention comes out remarkably in a system having a high process speed (135

mm/s or more; the operating speed of the above process in which the electrophotographic photosensitive member is charged, the electrostatic latent image is formed by exposure and developed with a toner, the toner image  
5 formed is transferred to paper or the like and thereafter the electrophotographic photosensitive member surface is cleaned), and a system making use of a cleaning blade as the cleaning means.

The present invention is described below in  
10 greater detail by giving Examples.

#### Synthesis Example 1

3.6 g of N,N'-di(3-methylphenyl)benzidine, 1.56 g of 2,7-dibromobiphenyl and 1.7 g of 2,8-dibromodibenzothiophene were dissolved in 20 ml of  
15 dry o-xylene, followed by addition of 10 mg of palladium acetate, 55 mg of 2-(di-tert-butylphospheno)biphenyl and 1.34 g of tert-butoxysodium to effect heating and reflux for 4 hours, and further followed by addition of 0.5 g of 4-bromotoluene to effect heating and reflux for 2  
20 hours.

The resulting reaction mixture was left to cool, from which the catalyst was removed thereafter, and then poured into acetone to obtain a yellow solid.

The solid thus obtained was further again  
25 dissolved in toluene, and subjected to treatment with activated carbon, column chromatography and reprecipitation to effect purification, to obtain 3.5 g

of a pale yellow solid.

This pale yellow solid was the random-copolymer type high-molecular-weight charge-transporting material CTP-1, having CT-2 to CT-45 compositional ratio (molar ratio) of 50:50.

#### Synthesis Example 2

3.6 g of N,N'-di(3-methylphenyl)benzidine, 3.25 g of 2,7-diiodobiphenyl and 0.84 g of 2,8-diiododibenzofuran were dissolved in 10 ml of o-dichlorobenzene, followed by addition of 3.1 g of copper powder and 3.8 g of potassium carbonate to effect heating and reflux for 8 hours.

The resulting reaction mixture was left to cool, from which the catalyst was removed thereafter, and then poured into acetone to obtain a yellow solid.

The solid thus obtained was further again dissolved in toluene, and subjected to treatment with activated carbon, column chromatography and reprecipitation to effect purification, to obtain 3.2 g of a pale yellow solid.

This pale yellow solid was the random-copolymer type high-molecular-weight charge-transporting material CTP-3, having CT-2 to CT-74 compositional ratio (molar ratio) of 80:20.

#### Synthesis Example 3

2.03 g of 2,7-dibromobiphenyl, 1.20 g of 2,8-dibromodibenzothiophene and 1.1 g of m-toluidine

were dissolved in 20 ml of dry o-xylene, followed by addition of 10 mg of palladium acetate, 55 mg of 2-(di-tert-butylphospheno)biphenyl and 1.30 g of tert-butoxysodium to effect heating and reflux for 6  
5 hours, and further followed by addition of 0.5 g of 4-bromotoluene to effect heating and reflux for 2 hours.

The resulting reaction mixture was left to cool, from which the catalyst was removed thereafter, and then poured into acetone to obtain a yellow solid.

10 The solid thus obtained was further again dissolved in toluene, and was subjected to treatment with activated carbon, column chromatography and reprecipitation to effect purification, to obtain 3.6 g of a pale yellow solid.

15 This pale yellow solid was the random-copolymer type high-molecular-weight charge-transporting material CTP-4, having CT-2 to CT-84 compositional ratio (molar ratio) of 65:35.

#### Synthesis Example 4

20 3.92 g of N,N'-di(1,4-dimethylphenyl)benzidine, 4.72 g of N,N'-di(3-trifluoromethylphenyl)benzidine and 8.12 g of 2,7-diiodobiphenyl were dissolved in 10 ml of o-dichlorobenzene, followed by addition of 6.4 g of copper powder and 5.5 g of potassium carbonate to effect  
25 heating and reflux for 8 hours.

The resulting reaction mixture was left to cool, from which the catalyst was removed thereafter, and then

poured into acetone to obtain a yellow solid.

The solid thus obtained was further again dissolved in toluene, and subjected to treatment with activated carbon, column chromatography and  
5 reprecipitation to effect purification, to obtain 6.5 g of a pale yellow solid.

This pale yellow solid was the random-copolymer type high-molecular-weight charge-transporting material CTP-21, having CT-2 to CT-17 compositional ratio (molar  
10 ratio) of 50:50.

Other random-copolymer type high-molecular-weight charge-transporting materials are also obtainable in the same way as in Synthesis Examples 1 to 4.

In the following Examples, "part(s)" refers to  
15 "part(s) by weight".

#### Example 1

An aluminum cylinder of 30 mm in diameter and 357.5 mm in length was used as the support. This support was dip-coated thereon with a conductive layer  
20 forming coating dispersion made up of the following materials, followed by heat curing at 140° for 30 minutes to form a conductive layer with a layer thickness of 15  $\mu\text{m}$ .

Conductive pigment:  $\text{SnO}_2$ -coated barium sulfate

25		10 parts
	Resistance-adjusting pigment: Titanium oxide	2 parts
	Binder resin: Phenol resin	6 parts

Leveling agent: Silicone oil 0.001 part

Solvent: Methanol/methoxypropanol = 2/8 20 parts

Next, 3 parts of N-methoxymethylated nylon and 3 parts of copolymer nylon were dissolved in a mixed solvent of 65 parts of methanol and 30 parts of n-butanol to prepare a solution, and this was dip-coated on the conductive layer, followed by drying to form an intermediate layer with a layer thickness of 0.5  $\mu\text{m}$ .

Next, 4 parts of hydroxygallium phthalocyanine crystals of a crystal form having strong peaks at Bragg's angles ( $2\theta \pm 0.2^\circ$ ) of  $7.3^\circ$  and  $28.1^\circ$  in the  $\text{CuK}\alpha$  characteristic X-ray diffraction, 2 parts of polyvinyl butyral resin (trade name: S-LEC BX-1; available from Sekisui Chemical Co., Ltd.) and 60 parts of cyclohexanone were subjected to dispersion for 4 hours by means of a sand mill making use of glass beads of 1 mm in diameter, followed by addition of 100 parts of ethyl acetate to prepare a charge generation layer coating dispersion. This charge generation layer coating dispersion was dip-coated on the intermediate layer, followed by drying at  $100^\circ\text{C}$  for 10 minutes to form a charge generation layer with a layer thickness of 0.3  $\mu\text{m}$ .

Next, 4 parts of the random-copolymer type high-molecular-weight charge-transporting material CTP-1 obtained in Synthesis Example 1 and 10 parts of polycarbonate resin (trade name: IUPILON Z-400;

available from Mitsubishi Engineering Co., Ltd.) were dissolved in a mixed solvent of 80 parts of monochlorobenzene and 20 parts of dichloromethane to prepare a charge transport layer coating solution. This  
5 charge transport layer coating solution was dip-coated on the charge generation layer, followed by drying at 120°C for 1 hour to form a charge transport layer with a layer thickness of 25  $\mu\text{m}$ .

Thus, an electrophotographic photosensitive member  
10 was produced whose charge transport layer was the surface layer.

Next, the electrophotographic photosensitive member produced was evaluated as described below.

An evaluation apparatus is a remodeled machine of a  
15 laser beam printer LBP-950 (process speed: 144.5 mm/s), manufactured by CANON INC., having construction as shown in Figure. Its charging means is a contact charging means making use of a charging roller. A DC voltage on which an AC voltage has been superimposed is applied to  
20 the charging roller. This has been so remodeled that the control of charging is changed from constant-current control to constant-voltage control, and also the peak-to-peak voltage of AC voltage is set higher by 30%.

The electrophotographic photosensitive member  
25 produced was set in this evaluation apparatus. In an environment of high temperature and high humidity (H/H: 28°C, 90%RH), a paper feed running test was conducted.



As its sequence, an intermittent mode was set up in which the printing was posed once for each sheet. When the toner runned up, it was replenished to continue the running test until any problem arose on images.

5       The surface of the electrophotographic photosensitive member was also made to wear for 18 hours by means of a Taber abrader making use of a polishing tape, to measure weight loss upon abrasion (Taber-volume loss).

10       Part of the electrophotographic photosensitive member surface was also irradiated by light of a white fluorescent lamp of 3,000 lux for 15 minutes, where this was left for 5 minutes and thereafter its light-area potential was measured to measure the extent to which  
15 the light-area potential lowered from the time before the irradiation by light. The measured value was regarded as the value of photomemory.

To further examine solvent cracking proofness, finger sebum was made to adhere to the  
20 electrophotographic photosensitive member surface. This was left for 80 hours, and then whether or not solvent cracking occurred was observed by microscopic observation.

The results of evaluation are shown in Table 5.

25       Examples 2 to 38

Electrophotographic photosensitive members were produced in the same manner as in Example 1 except that

the random-copolymer type high-molecular-weight charge-transporting material used therein in the charge transport layer was changed for those having the structure, compositional ratio and weight-average  
5 molecular weight as shown in Tables 3 and 4. Evaluation was made in the same way.

The results of evaluation are shown in Tables 5 and 6.

Table 3

Random-copolymer type high-molecular-weight charge-transporting material							
5		Struc- ture	Repeating structural unit			Composi- tional ratio (molar ratio) (1)/(2)/(3)	Weight= average mole- cular weight (Mw)
			(1)	(2)	(3)		
10	Example:						
	1	CTP-1	CT-2	CT-45	-	50/50/-	3,800
15	2	CTP-2	CT-2	CT-64	-	70/30/-	4,300
	3	CTP-3	CT-2	CT-74	-	80/20/-	4,200
	4	CTP-4	CT-2	CT-84	-	65/35/-	4,000
20	5	CTP-5	CT-2	CT-84	-	90/10/-	5,200
	6	CTP-6	CT-4	CT-46	-	70/30/-	3,600
25	7	CTP-7	CT-4	CT-61	-	70/30/-	2,900
	8	CTP-8	CT-4	CT-76	-	80/20/-	3,500
	9	CTP-9	CT-4	CT-86	-	80/20/-	4,000
30	10	CTP-10	CT-5	CT-69	-	60/40/-	2,600
	11	CTP-11	CT-24	CT-73	-	50/50/-	3,500
35	12	CTP-12	CT-27	CT-91	-	70/30/-	3,600
	13	CTP-13	CT-48	CT-77	-	80/20/-	4,500
	14	CTP-14	CT-61	CT-83	-	90/10/-	4,300
40	15	CTP-15	CT-76	CT-86	-	60/40/-	4,400
	16	CTP-16	CT-79	CT-91	-	50/50/-	3,200
45	17	CTP-17	CT-2	CT-9	CT-76	60/30/10	3,600
	18	CTP-18	CT-2	CT-59	CT-90	70/20/10	3,700
	19	CTP-19	CT-4	CT-69	CT-74	80/10/10	3,600
50	20	CTP-20	CT-4	CT-70	CT-92	50/40/10	4,000

Table 4

Random-copolymer type high-molecular-weight charge-transporting material							
10	Struc- ture	Repeating structural unit			Composi- tional ratio (molar ratio) (1)/(2)/(3)	Weight= average mole- cular weight (Mw)	
		(1)	(2)	(3)			
		Example:					
15	21	CTP-21	CT-2	CT-17	-	50/50/-	3,600
	22	CTP-22	CT-2	CT-16	-	70/30/-	4,200
	23	CTP-23	CT-2	CT-9	-	80/20/-	4,200
20	24	CTP-24	CT-2	CT-13	-	65/35/-	4,000
	25	CTP-25	CT-4	CT-17	-	90/10/-	4,300
25	26	CTP-26	CT-4	CT-8	-	80/20/-	3,600
	27	CTP-27	CT-4	CT-15	-	70/30/-	2,900
	28	CTP-28	CT-6	CT-20	-	95/5/-	3,500
30	29	CTP-29	CT-24	CT-13	-	85/15/-	4,100
	30	CTP-30	CT-29	CT-9	-	60/40/-	2,800
35	31	CTP-31	CT-39	CT-43	-	90/10/-	3,500
	32	CTP-32	CT-45	CT-52	-	70/30/-	3,600
	33	CTP-33	CT-45	CT-56	-	80/20/-	4,500
40	34	CTP-34	CT-45	CT-57	-	90/10/-	4,300
	35	CTP-35	CT-2	CT-16	CT-48	70/20/10	3,800
45	36	CTP-36	CT-2	CT-11	CT-60	70/20/10	3,700
	37	CTP-37	CT-4	CT-13	CT-52	80/10/10	3,600
50	38	CTP-38	CT-4	CT-12	CT-49	50/40/10	4,000

Table 5

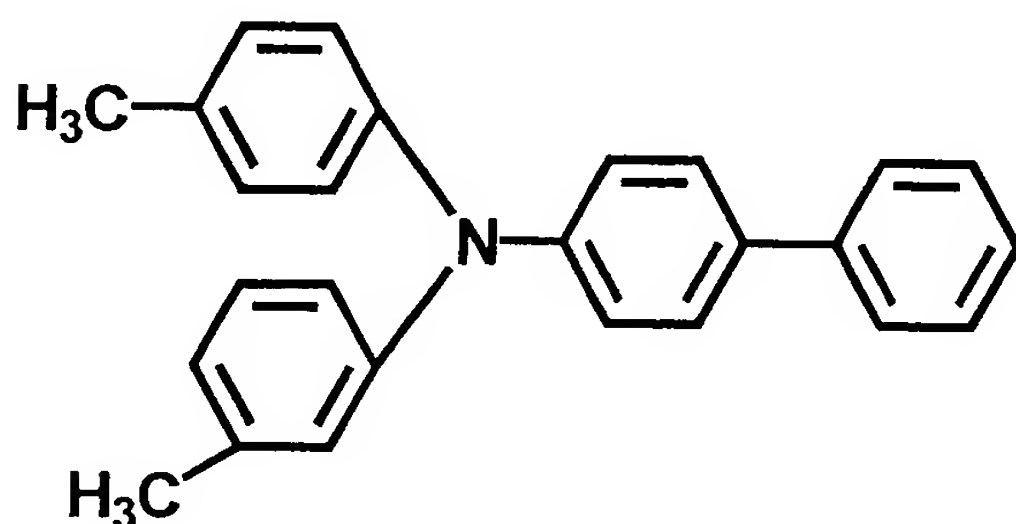
5		<u>Running limit value in H/H</u>	<u>Taber= volume loss</u>	<u>Photo- memory</u>	<u>Solvent cracking</u>
	Example:				
		Fog occurred on:			
10	1	45,000th sheet.	2.7 mg	15	Unseen.
	2	43,000th sheet.	2.8 mg	15	Unseen.
15	3	48,000th sheet.	2.6 mg	20	Unseen.
	4	49,000th sheet.	2.7 mg	15	Unseen.
	5	47,000th sheet.	2.9 mg	20	Unseen.
20	6	46,000th sheet.	2.6 mg	15	Unseen.
	7	46,000th sheet.	2.4 mg	20	Unseen.
25	8	51,000th sheet.	2.6 mg	20	Unseen.
	9	52,000th sheet.	2.7 mg	20	Unseen.
	10	47,000th sheet.	2.5 mg	15	Unseen.
30	11	47,000th sheet.	2.8 mg	20	Unseen.
	12	46,000th sheet.	2.6 mg	15	Unseen.
35	13	45,000th sheet.	2.7 mg	20	Unseen.
	14	45,000th sheet.	2.8 mg	20	Unseen.
	15	46,000th sheet.	3.0 mg	15	Unseen.
40	16	45,000th sheet.	2.8 mg	20	Unseen.
	17	46,000th sheet.	2.6 mg	15	Unseen.
45	18	45,000th sheet.	2.6 mg	20	Unseen.
	19	45,000th sheet.	2.8 mg	15	Unseen.
50	20	46,000th sheet.	2.9 mg	20	Unseen.

Table 6

5		<u>Running limit value in H/H</u>	<u>Taber= volume loss</u>	<u>Photo- memory</u>	<u>Solvent cracking</u>
	Example:	Fog occurred on:			
10	21	47,000th sheet.	2.6 mg	15	Unseen.
	22	45,000th sheet.	2.8 mg	15	Unseen.
	23	52,000th sheet.	2.7 mg	15	Unseen.
15	24	45,000th sheet.	2.7 mg	15	Unseen.
	25	49,000th sheet.	2.7 mg	20	Unseen.
20	26	48,000th sheet.	2.6 mg	15	Unseen.
	27	46,000th sheet.	2.5 mg	25	Unseen.
	28	47,000th sheet.	2.5 mg	20	Unseen.
25	29	46,000th sheet.	2.7 mg	25	Unseen.
	30	46,000th sheet.	2.5 mg	15	Unseen.
30	31	47,000th sheet.	2.7 mg	20	Unseen.
	32	52,000th sheet.	2.6 mg	15	Unseen.
	33	48,000th sheet.	2.6 mg	20	Unseen.
35	34	45,000th sheet.	2.7 mg	15	Unseen.
	35	46,000th sheet.	2.6 mg	15	Unseen.
40	36	47,000th sheet.	2.6 mg	15	Unseen.
	37	46,000th sheet.	2.7 mg	15	Unseen.
	38	44,000th sheet.	2.9 mg	20	Unseen.
45					

### Comparative Example 1

An electrophotographic photosensitive member was produced in the same manner as in Example 1 except that the random-copolymer type high-molecular-weight charge-transporting material used therein in the charge transport layer was changed for a compound having structure represented by the following formula. Evaluation was made in the same way.



### Comparative Example 2

An electrophotographic photosensitive member was produced in the same manner as in Example 1 except that the random-copolymer type high-molecular-weight charge-transporting material used therein in the charge transport layer was changed for a homopolymer having the repeating structural unit represented by Formula CT-2 (weight-average molecular weight Mw: 4,000). Evaluation was made in the same way.

### Comparative Example 3

An electrophotographic photosensitive member was produced in the same manner as in Example 1 except that the random-copolymer type high-molecular-weight

charge-transporting material used therein in the charge transport layer was changed for a homopolymer having the repeating structural unit represented by Formula CT-39 (weight-average molecular weight Mw: 3,200). Evaluation  
5 was made in the same way.

#### Comparative Example 4

An electrophotographic photosensitive member was produced in the same manner as in Example 1 except that the random-copolymer type high-molecular-weight  
10 charge-transporting material used therein in the charge transport layer was changed for an alternating copolymer having the repeating structural unit represented by Formula CT-45 and the repeating structural unit represented by Formula CT-84 (weight-average molecular  
15 weight Mw: 3,500; copolymerization ratio 50:50). Evaluation was made in the same way.

#### Comparative Example 5

An electrophotographic photosensitive member was produced in the same manner as in Example 2 except that  
20 the random-copolymer type high-molecular-weight charge-transporting material used therein in the charge transport layer was changed for a block copolymer obtained by block-copolymerizing the same material in the same composition (weight-average molecular weight  
25 Mw: 4,100). Evaluation was made in the same way.

The results of evaluation of Comparative Examples 1 to 5 are shown in Table 7.



Table 7

5		<u>Running limit</u> <u>value in H/H</u>	<u>Taber=</u> <u>volume</u> <u>loss</u>	<u>Photo-</u> <u>memory</u>	<u>Solvent</u> <u>cracking</u>
	Comparative Example:				
10	1	Low density from the beginning. Fog occurred on 23,000th sheet.	4.2 mg	80	Seen.
15	2	Smeared images appeared on 1,000th sheet.	2.8 mg	35	Seen.
	3	Smeared images appeared on 2,000th sheet.	2.9 mg	35	Seen.
20	4	Fog occurred on 40,000th sheet.	2.7 mg	25	Seen.
25	5	Fog occurred on 26,000th sheet.	3.5 mg	20	Seen.

30 Examples 39 to 44

Electrophotographic photosensitive members were produced in the same manner as in Examples 1 to 3 and 21 to 23, respectively, except that the random-copolymer type high-molecular-weight charge-transporting materials used therein in the charge transport layers were each changed to have the weight-average molecular weight shown in Table 8. Evaluation was made in the same way.

The results of evaluation are shown in Table 9.

Table 8

Random-copolymer type high-molecular-weight charge-transporting material							
10	Struc- ture	Repeating structural unit			Composi- tional ratio (molar ratio) (1)/(2)/(3)	Weight= average mole- cular weight (Mw)	
		(1)	(2)	(3)			
Example:							
15	39	CTP-1	CT-2	CT-45	-	50/50/-	1,200
	40	CTP-2	CT-2	CT-64	-	70/30/-	800
	41	CTP-3	CT-2	CT-74	-	80/20/-	600
20	42	CTP-21	CT-2	CT-17	-	50/50/-	1,200
	43	CTP-22	CT-2	CT-16	-	70/30/-	800
	44	CTP-23	CT-2	CT-9	-	80/20/-	600
25							

Table 9

30					
	Running limit value in H/H		Taber= volume loss	Photo- memory	Solvent cracking
35	Example:				
	Fog occurred on:				
40	39	31,000th sheet.	3.1 mg	15	Unseen.
	40	28,000th sheet.	3.4 mg	15	Unseen.
	41	26,000th sheet.	3.5 mg	20	Unseen.
	42	31,000th sheet.	3.1 mg	15	Unseen.
45	43	28,000th sheet.	3.4 mg	15	Unseen.
	44	26,000th sheet.	3.5 mg	20	Unseen.

Examples 45 to 52

Electrophotographic photosensitive members were produced in the same manner as in Examples 1, 2, 21 and 22, respectively, except that the binder resins used therein in the charge transport layers were each changed as shown in Table 10. Evaluation was made in the same way.

The results of evaluation are shown in Table 11.

10

Table 10

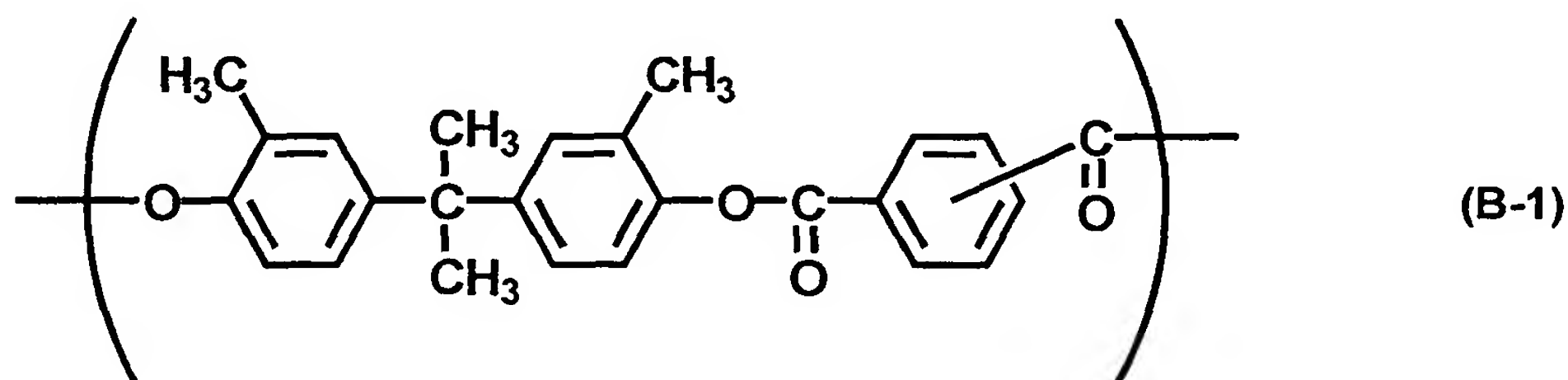
Random-copolymer type high-molecular-weight charge-transporting material						Binder resin		
15	Struc- ture	Repeating structural unit		Composi- tional ratio (molar ratio) (1) / (2)	Weight- average mole- cular weight (Mw)	Struc- ture	Weight- average mole- cular weight (Mw)	
		(1)	(2)					
20	Example:							
25	45	CTP-1	CT-2	CT-45	50/50	3,800	B-1	100,000
	46	CTP-2	CT-2	CT-64	70/30	4,300	B-1	100,000
	47	CTP-1	CT-2	CT-45	50/50	3,800	B-2	130,000
30	48	CTP-2	CT-2	CT-64	70/30	4,300	B-2	130,000
	49	CTP-21	CT-2	CT-17	50/50	3,600	B-1	100,000
35	50	CTP-22	CT-2	CT-16	70/30	4,200	B-1	100,000
	51	CTP-21	CT-2	CT-17	50/50	3,600	B-2	130,000
	52	CTP-22	CT-2	CT-16	70/30	4,200	B-2	130,000
40								

40

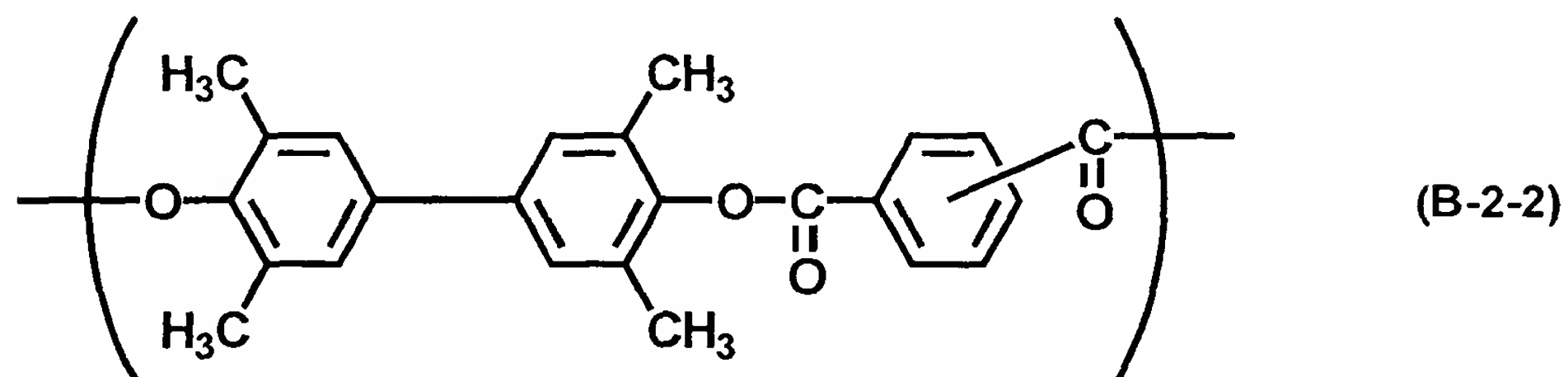
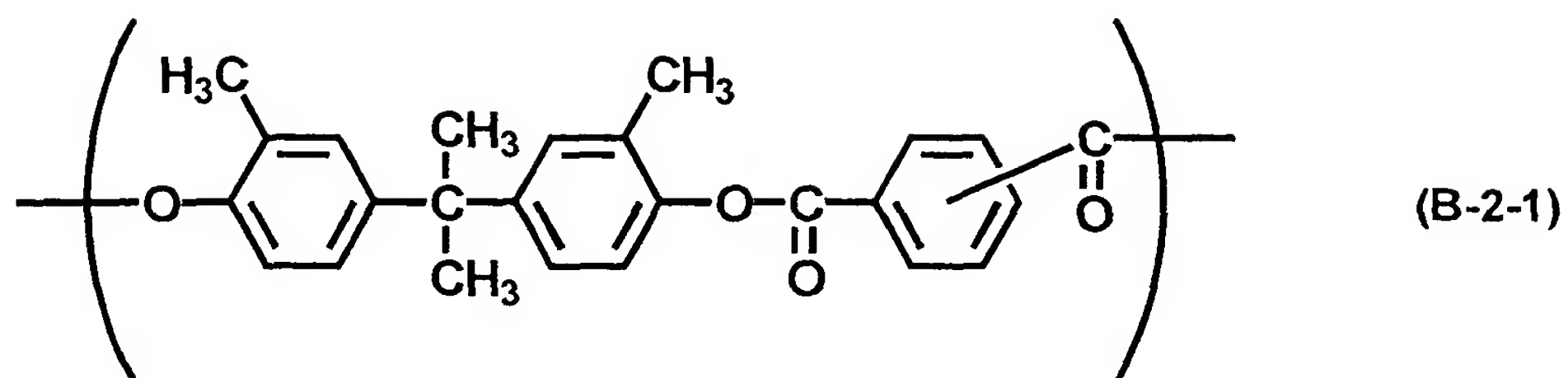
Table 11

		<u>Running limit value in H/H</u>	<u>Taber= volume loss</u>	<u>Photo- memory</u>	<u>Solvent cracking</u>
5					
	Example:				
		Fog occurred on:			
10	45	75,000th sheet.	1.5 mg	15	Unseen.
	46	74,000th sheet.	1.6 mg	15	Unseen.
15	47	110,000th sheet.	1.4 mg	20	Unseen.
	48	107,000th sheet.	1.5 mg	25	Unseen.
	49	78,000th sheet.	1.8 mg	15	Unseen.
20	50	75,000th sheet.	1.9 mg	15	Unseen.
	51	103,000th sheet.	1.5 mg	15	Unseen.
25	52	104,000th sheet.	1.4 mg	20	Unseen.

Here, the binder resin B-1 is a homopolymer having a repeating structural unit represented by the following  
30 Formula B-1.



The binder resin B-2 is also a copolymer having a repeating structural unit represented by the following  
35 Formula B-2-1 and a repeating structural unit represented by the following Formula B-2-2.



According to the present invention, the electrophotographic photosensitive member can be provided which has high surface mechanical strength, has superior durability (wear resistance or scratch resistance) and also has stability in repeated use, and the process cartridge and the electrophotographic apparatus which have such an electrophotographic photosensitive member.